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Energy from Fossil Fuels

M. King Hubbert, *Associate Director,*
Exploration and Production Research Division, Shell Oil Company, Inc.

THE EARTH MAY BE REGARDED as a material system whose gain or loss of matter over the period of our interest is negligible. Into and out of this system, however, there occurs a continuous flux of energy, in consequence of which the material constituents of the surface of the earth undergo continuous or intermittent circulation. For the present discussion we shall restrict our attention to the nonradioactive materials. The preponderance of the energy involved in this process is that derived from solar radiation, and a small fraction of the matter at or near the surface of the earth occurs in the peculiar aggregates known as living organisms. From geological evidence, organisms have existed upon the earth for probably as long as a billion years, and it appears that evolution had proceeded far enough that a species recognizable as *man* must have existed roughly a million years ago. The population of this species at that stage is unknown but evidently was not large. It existed in some sort of ecological adjustment with the rest of the organic complex, and competed with the other members of the complex for a share of solar energy essential to its existence. At that hypothetical stage its sole capacity for the utilization of energy consisted in the food it was able to eat—the order of 2,000 kilogram-calories per capita per day.

Emancipation from this dependence upon contemporary solar energy was not possible until some other and hitherto unknown source of energy became available. This had its beginning about the thirteenth century when some of the inhabitants of Britain made the discovery that certain black rocks found along the shore of the East Coast, and thereafter known as "sea coles," would burn. From this discovery there followed in almost inevitable succession the mining of coal and its use for the smelting of metals, the development of the steam engine, the locomotive, the steamship, and steam-electric power.

This development was further augmented when, about a century ago, the second large source of fossil energy—petroleum and natural gas—was tapped, leading to the internal combustion engine, the automobile, the aeroplane, and Diesel-electric power.

A third source of fossil energy, oil shale, although exploited on a small scale for almost a century, is only now approaching its phase of rapid development.

Rates of Production

It is to the rate of increase and the magnitude of the consumption of energy from fossil fuels that I now wish to direct your attention.

Consider coal. Although production statistics for the earlier periods are not available, it is known that from the initial discovery and use of "sea coles" to the present there has been a continuous increase in the rate of consumption of this commodity. During the eighteenth century the need for power for the coal mines led to the development of the steam engine, and the demand for better means of transportation led first to the railroad and then to the steam locomotive. We know also that before the end of the eighteenth century the employment of this new source of energy had reached such a magnitude in Britain as to produce the major social and economic disturbances referred to as the "Industrial Revolution."

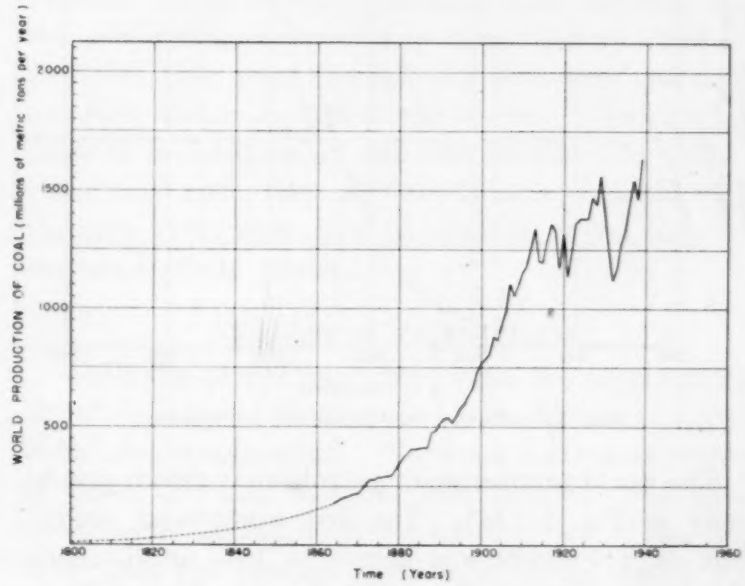

FIG. 1. World production of coal.

By 1864 (*11, 12*) (Fig. 1), from which date annual world production statistics are available, the annual production of coal in the world had reached about 180 million metric tons per year, and from that date until 1914, when it had reached a rate of 1,300 million tons per year, it continued to increase geometrically at a rate of 4 percent per year, or at a rate such that the annual production was doubling every 17 years.

"Energy from Fossil Fuels" was one of the papers presented as part of the Symposium on Sources of Energy, held in Washington, D. C., on September 15, during the Centennial Celebration of the AAAS.

The length of time during which coal has been mined is likely to be misleading. To appreciate the magnitude of what is happening and the brevity of time during which most of it has occurred, consider these facts: By the end of 1947 the cumulative production of coal during all past human history amounted to approximately 81 billion metric tons. Of this, 40 billion, or approximately one half, has been mined and consumed since 1920. Sixty-two billion, or more than three-quarters, has been produced since 1900.

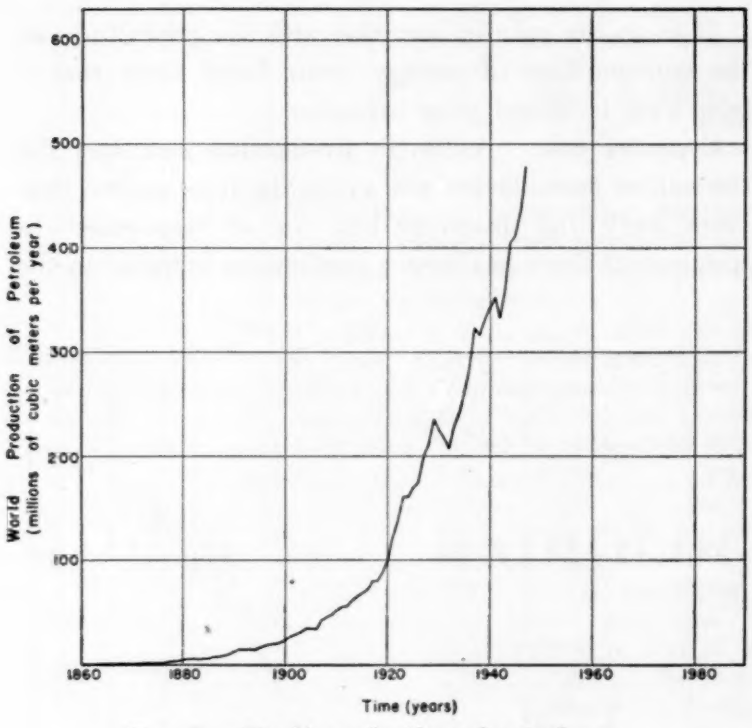

FIG. 2. World production of petroleum.

The world production of petroleum is shown graphically in Fig. 2 (*13*). The first commercial production of petroleum was begun in 1857 in Rumania. Two years later the first oil well in the United States was completed. From these beginnings, with only an occasional setback, the world production of petroleum has increased spectacularly, reaching by the end of 1947 an annual rate of 477 million cubic meters (3 billion U. S. barrels). From 1860 to 1929 the rate of production doubled, on the average, every 7½ years, or at an average annual rate of increase of slightly more than 9 percent. Since 1929 the rate of increase has declined somewhat and the doubling period increased to about 15 years.

Again, to emphasize the brevity of time during which most of this has occurred, the cumulative production by the end of 1947 was 9.17 billion cubic meters (57.7 billion U. S. barrels). Of this, one-half has been produced and consumed since 1937, or during the last 10 years, and 97 percent since 1900.

The energy content of the coal and petroleum which has been consumed, expressed in kilogram-calories, is shown in Fig. 3. From these two sources the energy per year amounted in 1939 to 15×10^{15}, or 15 thousand trillion, kilogram-calories per year, of which approximately four-fifths and one-fifth were contributed by coal and petroleum respectively.

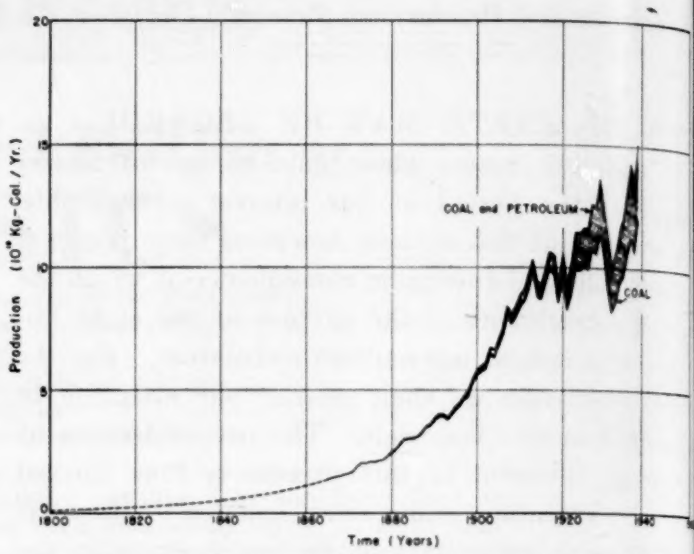

FIG. 3. World production of energy from coal and petroleum.

Because of the lack of world production statistics, the energy from natural gas has not been included. In the United States about 400 cubic meters of natural gas are produced for each cubic meter of oil, with an energy content of about four-tenths that of oil. Since oil and gas are genetically related it may be presumed that this approximate ratio is valid for the rest of the world also. Hence, the energy from the natural gas that has been produced may be assumed to be at least 40 percent of that of petroleum.

GROWTH OF POPULATION

One of the most disturbing ecological influences of recent millennia is the human species' proclivity for

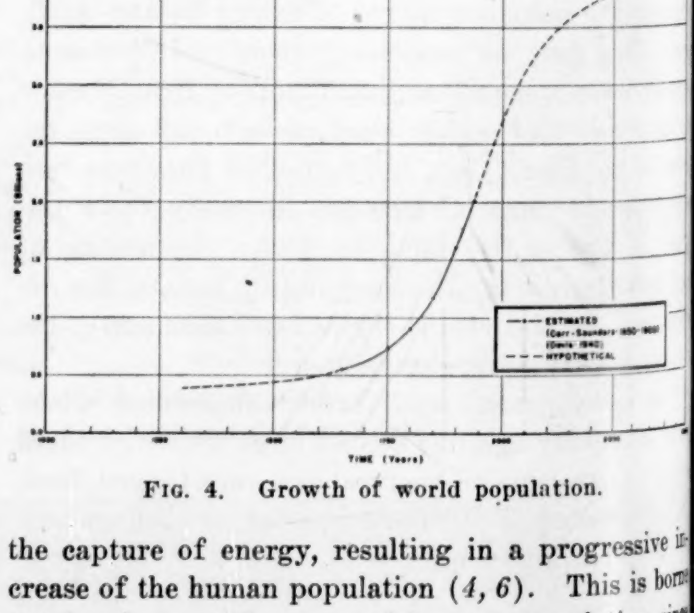

FIG. 4. Growth of world population.

the capture of energy, resulting in a progressive increase of the human population (*4, 6*). This is borne out by the growth curve of human population since 1650, shown in Fig. 4, based on the studies of Carr-Saunders (*1*), and the recent estimate of Davis (*3*)

According to these estimates the world population has increased from about 545 million in 1650 to 2,171 million by 1940. The greatest rate of increase during this period has been that of the last half-century, during which the world population has been increasing at such a rate as to double itself every century, or at an annual rate of increase of 0.7 percent.

Such a rate is not "normal," as can be seen by backward extrapolation. If it had prevailed throughout human history, beginning with the mythical Adam and Eve, only 3,300 years would have been required to reach the present population. If, on the contrary, we assume the human race to have been in existence for a million years, and to have increased at a uniform exponential or geometrical rate, starting with a single pair, the present population would have been reached in that time by a rate of increase of 2.1×10^{-4} percent per year, or a rate of growth that would require 33,000 years for the population to double. At such a rate it is doubtful whether any census could detect a change in the population during one man's lifetime.

That the present rate of growth cannot long continue is also evident when we consider that at this rate only 200 more years would be required to reach a population of nearly 9 billion—about the maximum number of people the earth can support. In fact, at such a rate, only 1600 years would be required to reach a population density of one person for each square meter of the land surface of the earth.

Prior to 1800 most of the energy available to man was that derivable from his food, the labor of his animals, and the wood he used for fuel. On a world-wide basis it is doubtful if the sum of these exceeded 10,000 kilogram-calories per man per day, and this was a severalfold increase over the energy from food alone.

After 1800 there was superposed on top of these sources the energy from fossil fuels. From a world average of 300 kilogram-calories per capita per day in 1800 the energy from coal and petroleum increased to 9,880 by 1900, and to 22,100 by 1940. In the areas of high industrialization this quantity is much larger. In the United States, for example, the energy from coal and petroleum consumed per day per capita amounted in 1940 to 114,000 kilogram-calories (*2*); and from coal, petroleum, and natural gas, to 129,000.

Physical Limits to Expansion

From the foregoing data it should be clear that while we are concerned with a progression of ancient origin, the developments within the last century, and especially within the last few decades, are decidedly exceptional. One cannot refrain from asking, "Where is it taking us? How long can we keep it up?"

This leads us to consider what physical limitations there may be upon the various types of energy whose expansion we have noted. In the case of the fossil fuels the answer is simple. As remarked before, these fuels represent an accumulation over 500 million years of geologic time, and any additional accumulation that may be expected within the next 10,000 years is negligible. When these fuels are burned, their material content remains upon the earth in a relatively useless form, but the precious energy, after undergoing a sequence of degradations, finally leaves the earth as spent, long-wavelength, low-temperature radiation. Hence, we deal with an essentially fixed storehouse of energy which we are drawing upon at a phenomenal rate. The amount which remains at any given time equals the amount initially present less that which has been consumed already.

The amount consumed up to any given time is proportional to the area under the curve of annual production plotted against time. This area may approach but can never quite equal the amount initially present. Thus we may announce with certainty that the production curve of any given species of fossil fuel will rise, pass through one or several maxima, and then decline asymptotically to zero. Hence, while there is an infinity of different shapes that such a curve may have, they all have this in common: that the area under each must be equal to or less than the amount initially present.

Amounts of Fossil Fuels

While the quantities of fuels upon the earth are not known precisely, their order of magnitude is pretty definitely circumscribed. The most accurately known is coal. At the Twelfth International Geological Congress at Ottawa in 1913 a world review of coal was made and the amount capable of being mined was estimated to be about 8×10^{12} metric tons. Since that time some adjustments in the estimates have been made, giving us a present figure of about 6.3×10^{12} metric tons of coal initially present.

Within the last few years this figure has been criticized by mining engineers (*2, 5*) on the grounds that while the estimated amount of coal may in fact be present, the amount recoverable by practical mining operations is but a fraction—possibly as small as one-tenth—of the foregoing estimate. The degree of validity of this criticism still remains to be determined.

For petroleum the estimation is considerably less accurate than that for coal but still it is probably reliable as to the order of magnitude. The method of estimation in this case is that of sampling. In the better-known areas the amount of petroleum produced per unit volume of certain classes of rocks has been determined. The areas and volumes (within drillable depths) of similar rocks over the earth are fairly well known. By application of the same factor

for the undrilled areas as for those now well known, an order of magnitude of the petroleum that may exist may be obtained.

The most comprehensive studies so far made public appear to be those of Weeks, which are cited by Wallace E. Pratt (*1–9*). According to these studies, in a volume of 10–12.5 million cubic kilometers (2.5–3.0 million cubic miles) of sediments in the United States there have already been discovered 8.4×10^9 cubic meters (53×10^9 barrels) of oil. This represents about 10 percent of the total volume of such sediments of the land areas throughout the world. Hence, it is estimated that for the world there should have been present initially about ten times as much oil as for the United States. A similar volume of sediments occurs on the continental shelves, which may contain about as much oil as the land sediments.

Assuming that the land areas of the United States will produce 16×10^9 cubic meters (100 billion barrels), then a reasonable estimate for the world would be:

Land:	160×10^9 m^3
Continental Shelves:	160×10^9 m^3
Total:	320×10^9 m^3

These figures are regarded as being somewhat liberal and the quantity of oil may actually be considerably less. Not included in the figures are the Athabaska Tar Sands (*8*), estimated to contain about 30×10^9 cubic meters of oil.

The amount of natural gas may be estimated at 400 cubic meters of gas for one of oil, or at an energy content of 40 percent that of oil.

The oil shales of the world are less well known. Those of the United States, especially the Green River shales, are estimated to contain at least 55×10^9 cubic meters of oil. Assuming that the rest of the world has about three times the amount of oil shales in the United States, we would obtain, for an order of magnitude, 160×10^9 cubic meters (1,000 billion barrels) of oil from this source.

The results of these estimates are given in Table 1 and shown graphically in Fig. 5. It will be noted that 92 percent of the estimated total is represented by coal

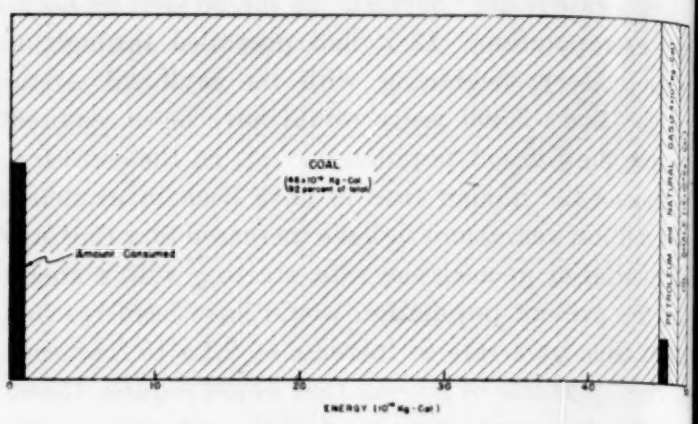

FIG. 5. Total energy of fossil fuels.

—a figure which will not be greatly altered by any reasonable adjustments of the estimates of the remaining fuels, but may be considerably altered if the minable amount of coal is less than usually assumed.

The amount of the initial coal already consumed is 1.35 percent; that of oil and natural gas, inclusive of the Athabaska Tar Sands, about 5 percent. The fraction of shale oil already produced is negligible. From these data the estimated initial supply of energy stored in fossil fuels is of the order of 50×10^{18} kilogram-calories, of which 0.7×10^{18}, or 1.5 percent, has already been consumed.

With this information we are prepared to consider what the future consumption of fossil energy may be. In Fig. 6 is shown the production of fossil energy up to the present, and two possible projections into the future. One production curve rises to a high peak

TABLE 1

ENERGY OF FOSSIL FUELS

Resource	Initially present		Percentage total initial energy	Already consumed		
	Quantity	Energy content (10^{18} kg-cal)		Quantity	Energy content (10^{18} kg-cal)	Initial (%)
Coal*	6.3×10^{12} metric tons	46.0	92.2	81×10^9 metric tons	0.59	1.3
Petroleum†	160×10^9m^3	1.5	3.0	9.17×10^9m^3	0.087	5.7
Tar Sands‡	30×10^9m^3	0.3	0.6	.....	.....	...
Natural Gas§ ..	64×10^{12}m^3	0.6	1.2	3.7×10^{12}m^3	0.035	5.7
Oil Shale‖	160×10^9m^3	1.5	3.0	.....	.....	...
Total	.....	49.9	100.0	.....	0.712	1.43

* Revised from estimate. Twelfth International Geological Congress (1913).
† Based on estimate of Wallace E. Pratt: "Petroleum on Continental Shelves" (*Bull. A.A.P.G. 31*, 1947, 657–672).
‡ Wallace E. Pratt. *Oil in the earth*. Lawrence: Univ. of Kansas Press, 1942. P. 44.
§ Based on gas/oil ratio of 400 m^3/m^3, or energy of gas = 0.4 energy of oil.
‖ Carl Belser: "Oil Shale Resources of Colorado, Utah and Wyoming" (*A.I.M.E. Tech. Publ. No. 2358*, May, 1948).

and descends steeply; the second rises more slowly to a lower maximum and descends gently. The area under each curve, however, is approximately the same —10 unit squares, each of which represents 5×10^{18} kilogram-calories.

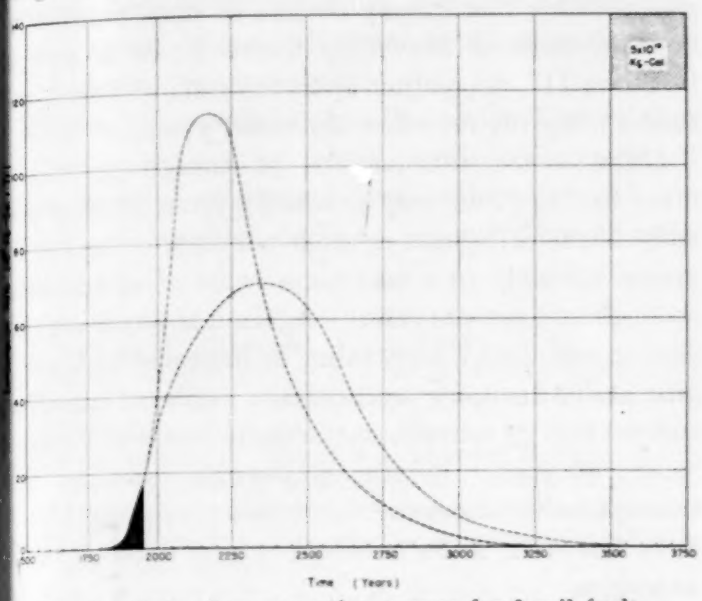

FIG. 6. Rate of consumption curves for fossil fuels.

If, as the coal mining engineers intimate, the amount of coal is much less than herein assumed, the area under the curve will be that much smaller and the approach to exhaustion that much sooner. How soon the decline may set in, it is not possible to say. Nevertheless the higher the peak of the production curve, the sooner and sharper will be the decline.

WATER POWER

The exploitation of water power, like that of coal, is of fairly ancient origin, but also like coal, until the last half-century its utilization has been small. Unlike fossil fuels, however, water power represents a fraction of current solar energy which changes but slowly with time, and is being continuously degraded into waste heat irrespective of whether it is utilized or not.

A growth curve of the utilization of water power, therefore, should rise in a manner similar to those of the fossil fuels, but instead of then declining to zero, it should level off asymptotically to a maximum as all available water power is brought into use. At least this is physically possible.

In view of the eventual exhaustion of fossil fuels, it is of interest to know to what extent water power can be depended upon to replace them. In Table 2 are listed the installed water power capacities of the various continents for the year 1947 and estimates of their total potential capacities (*10*), the number of kilowatt-hours of energy that such capacity should produce per year, and finally, the energy, expressed in heat units, of the amount of fuel that would be required to produce an equivalent amount of power.

In these calculations the potential installed capacity is taken to be equal approximately to the power at mean rate of flow and 100 percent efficiency. The estimated output is based on a load factor of 0.5, and the fuel equivalent of the power produced is based upon a thermodynamic efficiency of steam plants of 20 percent—figures which characterize installations in the United States at the present time.

TABLE 2

DEVELOPED AND POTENTIAL WATER POWER OF THE WORLD, 1947

Continent	Installed capacity*		Total potential water power				Potential output per year‡	
			Ord. min. flow*		Mean flow†		10^{12} kw-hrs	Energy of equivalent fuel§ 10^{15} kg-cal
	10^6 h-p	10^6 kw	10^6 h-p	10^6 kw	10^6 h-p	10^6 kw		
Africa	0.368	0.274	274	204	823	612	2.69	11.6
Asia	12.059	8.98	151	113	453	339	1.49	6.42
Europe	34.937	26.0	68	51	204	153	0.672	2.89
North America	35.849	26.7	84	63	252	189	0.824	3.54
Oceania	1.284	0.955	20	15	60	45	0.197	0.85
South America	2.392	1.79	67	50	201	150	0.658	2.83
Total	86.900	64.8	664	496	1992	1488	6.53	28.13

* U. S. Geological Survey, "Developed and Potential Water Power of the World" (1948).

† Computed on basis: average $\frac{\text{mean flow}}{\text{min. flow}} = 3$.

‡ Based on load factor of 0.5.

§ Computed on basis of efficiency of 20 percent for steam plants, or 4300 kg-cal/kw-hr.

The present and potential water power for the world is summarized graphically in Fig. 7. The potential capacity is about 1,500 million kilowatts of which present installations amount to only 65 million, or 4.3 percent.

The energy content of the equivalent fuel which would be required to produce the potential water

power output is about 28×10^{15} kilogram-calories per year, or one and a half times the present rate of consumption of energy from fossil fuels.

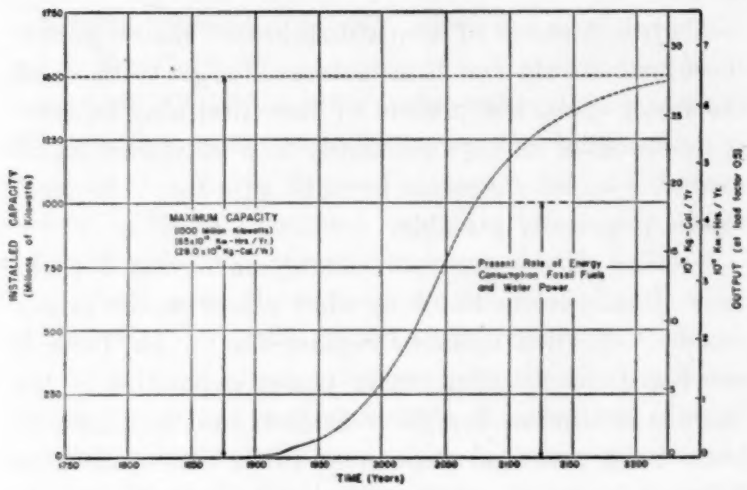
INSTALLED CAPACITY
MAXIMUM CAPACITY
Present Rate of Energy Consumption Fossil Fuels and Water Power
OUTPUT (at load factor 0.5)
TIME (Years)

FIG. 7. World potential water power.

Hence, with maximum utilization, it would be possible with water power to supply to the earth an amount of energy comparable to that currently obtained from the use of fossil fuels.

TIME PERSPECTIVE

The present state of human affairs can best be appreciated in the light of a time perspective, minus and plus, of some tens of thousands of years from the present, as depicted in Fig. 8. On such a time scale the phenomena we have discussed are represented by abrupt, nearly vertical rises from zero or near zero to maximum values. The consumption of energy from fossil fuels is thus seen to be but a "pip," rising sharply from zero to a maximum, and almost as sharply declining, and thus representing but a moment in the total of human history.

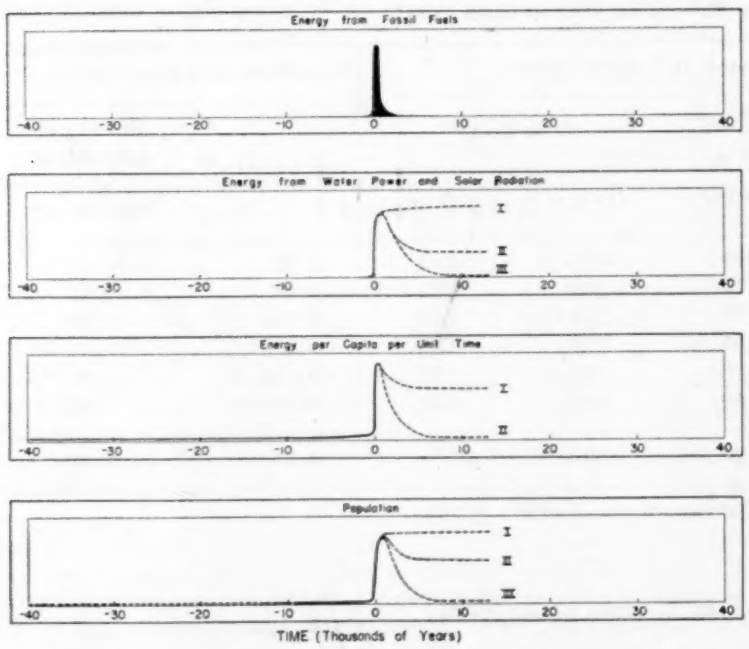

FIG. 8. Human affairs in time perspective.

The rate of consumption of energy from water power and solar radiation also rises almost vertically. It is physically capable of leveling off asymptotically to a maximum value as shown in Curve I and being held there more or less indefinitely. However, it is also possible that it may decline to some lower intermediate value as shown by Curve II, or to zero, as in Curve III, depending upon the state of human culture during the next few thousand years.

Likewise the consumption of energy per capita after having risen very gradually from 2,000 to possibly 10,000 kilogram-calories per day, is seen to increase suddenly to a maximum value of several times the highest previous value. Again it is physically possible to maintain a high value, as indicated by Curve I, on a stable basis for an indefinite period of time from current energy sources, particularly direct and indirect solar radiation. It also is possible, however, that through cultural degeneration this curve may decline, as in Curve II, to the subsistence level of our agrarian ancestors.

Viewed on such a time scale, the curve of human population would be flat and only slightly above zero for all preceding human history, and then it too would be seen to rise abruptly and almost vertically to a maximum value of several billion. Thereafter, depending largely upon what energy supplies are available, it might stabilize at a maximum value, as in Curve I, or more probably to a lower and more near optimum value, as in Curve II. However, should cultural degeneration occur so that the available energy resources should not be utilized, the human population would undoubtedly be reduced to a number appropriate to an agrarian existence, as in Curve III.

These sharp breaks in all the foregoing curves can be ascribed quite definitely, directly or indirectly, to the tapping of the large supplies of energy stored up in the fossil fuels. The release of this energy is a unidirectional and irreversible process. It can occur but once, and the historical events associated with this release are necessarily without precedent, and are intrinsically incapable of repetition.

It is clear, therefore, that our present position on the nearly vertical front slopes of these curves is a precarious one, and that the events which we are witnessing and experiencing, far from being "normal," are among the most abnormal and anomalous in the history of the world. Yet we cannot turn back; neither can we consolidate our gains and remain where we are. In fact, we have no choice but to proceed into a future which we may be assured will differ markedly from anything we have experienced thus far.

Among the inevitable characteristics of this future will be the progressive exhaustion of the mineral fuels and the accompanying transfer of the material

ents of the earth from naturally occurring deposits high concentration to states of low concentration semination. Yet despite this, it will still be physlly possible to stabilize the human population at me reasonable figure, and by means of the energy om sunshine alone to utilize low-grade concentraons of materials and still maintain a high-energy instrial civilization indefinitely.

Whether this possibility shall be realized, or whether shall continue as at present until a succession of ises develop—overpopulation, exhaustion of reurces and eventual decline—depends largely upon whether a serious cultural lag can be overcome. In view of the rapidity with which the transition to our present state has occurred it is not surprising that such a cultural lag should exist, and that we should continue to react to the fundamentally simple physical, chemical, and biological needs of our social complex with the sacred-cow behavior patterns of our agrarian and prescientific past. However, it is upon our ability to eliminate this lag and to evolve a culture more nearly in conformity with the limitations imposed upon us by the basic properties of matter and energy that the future of our civilization largely depends.

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Analysis of Microcomposition of Biological Tissue by Means of Induced Radioactivity

Cornelius A. Tobias and Rayburn W. Dunn[1]

Division of Medical Physics, Radiation Laboratory, and Department of Physics, University of California, Berkeley

RADIOACTIVE ISOTOPES HAVE FREQUENTLY been used for the determination of reaction rates and distribution of chemical ments and compounds in the animal body; for exple, the measurement of the total body water or the dium space (*6, 7, 9*). Some of the radionuclides, wever, cannot be used for determining the contrations of their stable isotopes in tissue because distribution of the administered radioactive tracer mple will not equilibrate, owing to absorption and retion. On the other hand, the radioactive isotopes n be used to indicate the rate of turnover of subnces in biochemical reactions. There are many imtant problems concerning "trace elements"[2] (e.g. see *11*) which involve knowledge of their distribution. The microchemical and spectroscopic methods of analysis which are now in use are not quantitative for most elements below 10^{-6} g/sample. It would be desirable to have methods of analysis which are accurate to well below this quantity. It seems certain that by using more highly sensitive methods of analysis much new information could be obtained concerning the biochemistry of trace elements in normal or diseased animals and plants.

Seaborg and Livingood (*10*) in 1938 solved a somewhat similar problem in their attempt to analyze for traces of gallium in iron. They exposed the gallium-contaminated sample to deuterons and determined the amount of gallium impurity by measuring the induced radioactivity. The use of this technique for biological studies was reported by us in 1947 (*12*) and later the same year by Brues and Robertson (*2*), who had used the technique independently. Clark and Overman (*3*) named the procedure "activation analysis." It may be used for biological research in more than one way. To learn the amount or concentration of

The authors acknowledge with pleasure the interest and laboration of Professor John H. Lawrence, the assistance Constance Tregillus and Robert Oswalt, and a useful dision with Professor E. M. McMillan. This work was carout under the auspices of the Atomic Energy Commission.

"Trace" elements are stable chemical elements, the pres- of which, in small quantities, is essential for the lives of ts and animals. "Tracers" are radioactive or stable isoes of elements which are suitable for study of the biochemi- and physiological role of these elements or their comnds.

various trace elements, one may take a sample of the tissue or tissue extract and, after proper processing, expose this sample to a source of nuclear particles, e.g. in a pile or cyclotron. Several of the elements present in this sample may become radioactive, and, after a known exposure, the amount of each newly formed radioactive isotope may be measured by standard radiochemical techniques. If a radioactive isotope A is formed from trace element B, the mass of the element B originally present in the sample may be calculated from the formula:

$$x = \frac{d \cdot A \cdot \varepsilon^{\lambda \cdot \tau}}{6.02 \cdot 10^{23} \cdot \sigma \cdot F(1 - \varepsilon^{-\lambda \cdot t})} \qquad (1)$$

where: x = unknown mass; A = atomic weight; F = particle flux; λ = decay constant of induced radioactivity; σ = cross section of B to form A; t = length of time of exposure to neutrons; τ = length of time elapsed between neutron exposure and time of measurement of rate of disintegration of the chemically separated sample A; and d = rate of disintegration of sample A measured at time τ.

The most convenient radiations to use are thermal neutrons produced by one of the chain-reacting piles. The above formula will hold true if the neutron flux remains constant throughout irradiation time, if the total amount of substance in the sample is not large enough to depress appreciably the neutron flux, and if the irradiation is not intense enough to significantly decrease the amount of isotope B to form isotope A. One does not always have to determine the absolute neutron flux in such a case. It is more convenient to measure the radioactivity induced after simultaneous irradiation of a known mass of element B. If neutrons are used as the activating agent, there are some 50 elements of biological importance which have large enough cross sections to make this technique an extremely sensitive one. Some of these elements are listed in Table 1.

Activation analysis may be also used for the study of distribution and metabolism of elements introduced into an organism in a manner somewhat analogous to the radioactive tracer technique. Thus, for example, an element may be introduced into the circulation of an animal, and its distribution, excretion, etc. may be observed at some later time. Experiments of this kind may not be legitimately called tracer experiments because the amount of the element added

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K	19	41	0.067	12.4 hr	1 T	5 T	4×10^{-8}
Ca	20	44	0.013	180 d	0.02 T	T	2.2×10^{-7}
Sc	21	45	22.0	85 d	0.2 T	2 T	10^{-10}
Cr	24	50	0.5	26.5 d	0.4 T	3 T	5×10^{-9}
Mn	25	55	10.7	2.59 hr	1 T	5 T	1.8×10^{-9}
Fe	26	58	0.001	47 d	0.2 T	5 T	2.5×10^{-6}
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Mo	42	98	0.1	67 hr	1 T	5 T	6.5×10^{-8}
Rh	45	103	137	44 sec	1 T	5 T	0.4×10^{-10}
Ag	47	109	1.1	225 d	0.05 T	0.3 T	1.6×10^{-8}
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Sb	51	121	3.8	2.8 d	1 T	5 T	2.4×10^{-9}
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the organism must always be larger or of the same order of magnitude as the amount already present. The metabolism of the element, therefore, may be altered during the process. Nevertheless, valuable data may be obtained regarding distribution and metabolism of minute quantities of certain elements. In some instances, the use of radioactive isotopes for such purposes requires that the radiation dose delivered to the tissues during the experiment be small to avoid disturbing biological functions. If certain tissues concentrate or selectively absorb the isotope, it is sometimes hard to avoid high dosage of such tissues. To be able to measure the concentration of the isotope in other parts of the body, one must administer a large dose. In addition, some of the radioactive isotopes have too short half lives to permit their prolonged observation in animals; one would have to give a large dose of such a tracer in order to allow for its decay during the experiment. On the other hand, activation analysis does not have these limitations in measuring distribution of elements.

One of the most attractive features of the method described in this paper is its extreme sensitivity. Formula 1 indicates the factors influencing this sensitivity, and one may say that the most important of these is the flux of particles. Using the published value for the flux density of the Clinton pile (*8*), the sensitivity of the method can be calculated for some elements to be as much as 1,000 times greater than that by any other known method. Other advantages are that one can determine the amounts of several elements present in the same sample simultaneously and, finally, that the method has a high specificity for certain elements. One should emphasize that the method is quantitative and that it will not require special techniques for individual elements except those of radio-chemistry.

In order to test the practicability of the ideas outlined above, some experiments were done using elements whose chemistry is easy and well known. Since

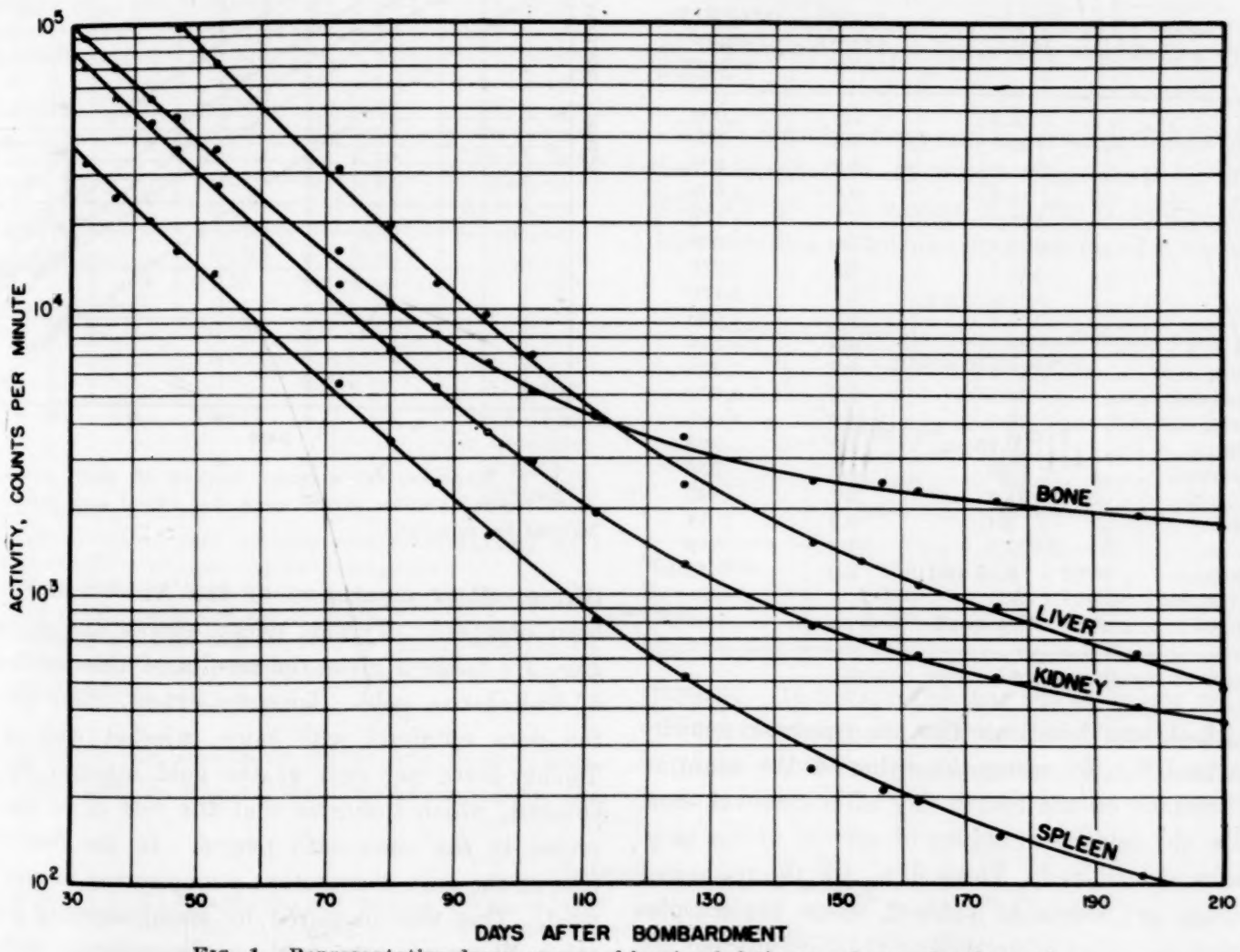

FIG. 1. Representative decay curves of bombarded tissue ash samples (mouse).

gold has an unusually large cross section for neutrons and since it is being used in this laboratory in connection with the study of rheumatoid arthritis (*1*), it appeared to be worth while to start with this element. The technique of its separation, deposition, and counting has been described by one of us (*5*). One normal female mouse, age six months, was injected in the tail vein with 10 μg of stable Au in the form of the soluble sodium gold thiosulfate salt. Upon autopsy and dissection a group of 19 repre-

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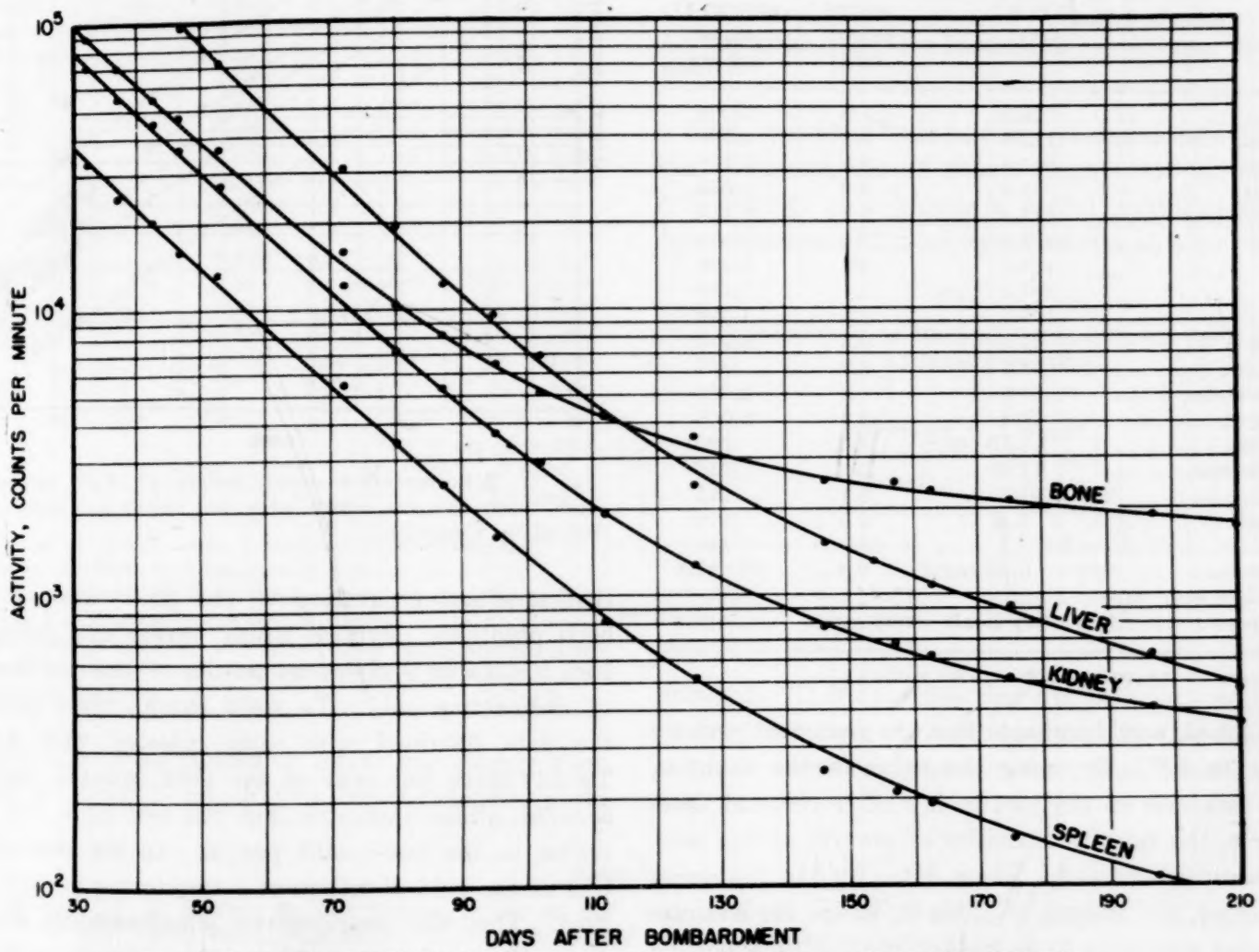

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sentative tissue samples was selected. Each sample was wet ashed, then irradicated by slow neutrons in a pile.[3] After irradiation and a suitable cooling period, the ash was dissolved in aqua regia. A small portion was used to prepare samples for counting. Typical decay curves from the counting of the latter are to be found in Fig. 1. Since counting began about one week after irradiation, some of the important short-lived isotopes are not present in these curves (Na^{24}, K^{42}, etc.) The effective half life of several of the tissue ash samples was found to be between 14 and 15

TABLE 2

RELATIVE RADIOACTIVITY OF IRRADIATED ASH ONE WEEK FOLLOWING EXPOSURE TO THERMAL NEUTRONS

Tissue	Wet wt (mg)	Estimated ash wt (mg)	Relative activity*/ mg of ash wt
Bone	29.8	7.9	1,000
Pancreas	179.6	3.9	1,500
Kidneys	305.6	3.9	1,720
Thymus	61.8	0.8	1,660
Spleen	141.4	2.7	1,110
Liver	1,458.8	57.0	500
Brain	436.1	6.8	1,220
Heart	107.2	1.1	1,780
Lung	175.2	2.1	1,500
Ovaries	21.8	0.3	1,110
Adrenals	11.6	0.2	830
Lymph nodes	30.8	0.2	1,660
Muscle	70.4	0.9	1,060
Red cells	0.15 (ml)	3.0	195
Gall bladder	14.6	0.1	830
Skin	101.6	5.1	145
Tendon	5.4	0.4	78
Gut	3,832.7	64.0	244
Plasma	0.15 (ml)	3.0	11.1
Control sample tube (empty)	very small	very small	.....

* Mean of measurements on two samples.

days, which would indicate that the principal activity is due to P^{32}. By using the value of the counting rates obtained on the fourth day after removal from the pile, the relative activities of several of the samples were determined. These data, for the tissues of the mouse, are shown in Table 2, where the samples are listed according to decreasing radioactivity per mg of wet tissue. Also listed are the activities per mg of estimated dry ash. The radioactivity per unit wet weight is roughly proportional to the phosphorus content of each organ, while the relative activity per mg dry ash weight is almost constant for most organs, indicating that the ash has an approximately constant percentage of phosphorus. At the end of 90 days the radioactivity of phosphorus decreased sufficiently to make some of the longer-lived components appear.

[3] Curtis and Teresi have previously demonstrated various radioactivities induced in tissues by neutrons (4).

Another portion of the solution was used to make radiochemical separations of various elements, in order to study the distribution of these elements and the administered gold. The first part of this work, namely, the study of the distribution of gold, is now complete. The activated gold was separated from each sample by precipitating it, with carrier, as the metal. The activities were determined after electroplating on platinum planchets. The half life of each sample was calculated. The values obtained showed

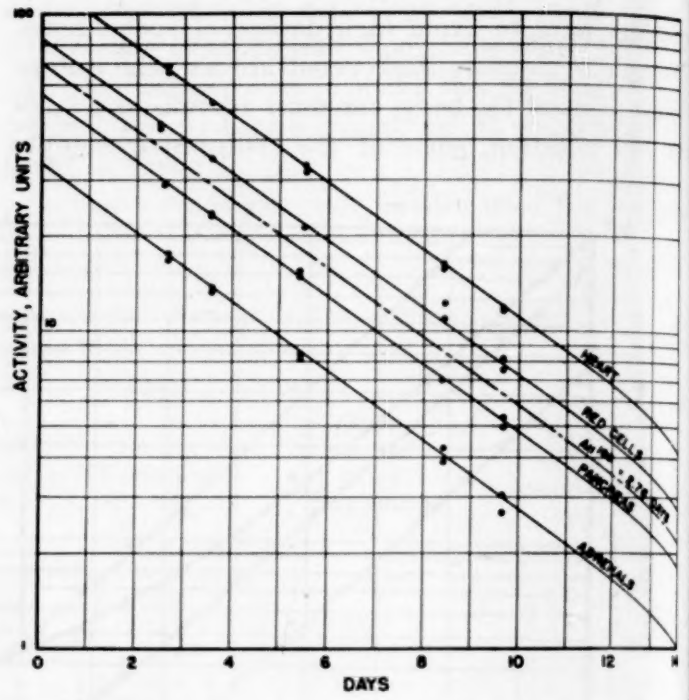

FIG. 2. Representative decay curves of Au^{198} recovered from tissue samples which were wet ashed and then bombarded by neutrons.

that excellent separation of the Au^{198} activity had been obtained. Typical decay curves are shown in Fig. 2. Table 3 gives the results of the distribution of radioactive gold. To some extent, these parallel the data obtained with mice injected with Au^{198}. Twenty-three per cent of the gold injected was recovered, which indicates that the rest of it was excreted in the one-month period. In the determination of the gold distribution a monitoring sample was used. This was prepared by simultaneously irradiating 10 μg of pure gold, as the chloride, with the same flux of neutrons as was received by the samples of mouse tissue. The activity of this gold sample was also used to calculate the neutron flux of the pile, since the cross section of Au^{197} for neutron capture is known.

In another experiment 20 ml of blood from a leukemic patient was fractionated into plasma, white cells, and red cells. These three ashed samples were also irradiated in the pile. The activity of the blood fractions, shown in Table 4, indicates that the relative radioactivity induced in the white cells per mg of dry

ash weight is about 10 times as high as that induced in red cells, or 50 times as high as the radioactivity induced in the plasma. Our attention is now focused on isolating the several isotopes which are responsible for the white cell radioactivity. The powerful possibilities which this technique offers are clearly illustrated in Table 5, which lists the Au found in the blood of a leukemic patient. The computations give 14 μg of gold for the total white cell volume of the body. To determine this small amount, one need use only about 10 cc of blood.

TABLE 3

DISTRIBUTION OF GOLD IN A MOUSE*

	Mass of organ (gm)	Amt of Au^{197}/gm of wet tissue (gm)	Total amt of Au^{197}/organ (gm)
Monitor gold sample	.....	.....	10×10^{-6}
Liver	1.458	4.4×10^{-7}	640×10^{-9}
Ovary	0.022	4.3×10^{-7}	9.5×19^{-9}
Thymus	0.062	3.2×10^{-7}	19×10^{-9}
Adrenals	0.012	3.1×10^{-7}	3.6×10^{-9}
Lung	0.175	2.6×10^{-7}	46×10^{-9}
Lymph nodes	0.031	2.2×10^{-7}	6.8×10^{-9}
Spleen	0.141	1.7×10^{-7}	24×10^{-9}
Kidney	0.306	1.6×10^{-7}	49×10^{-9}
Heart	0.107	1.5×10^{-7}	16×10^{-9}
Bone	2.600	1.1×10^{-7}	290×10^{-9}
Pancreas	0.015	1.1×10^{-7}	1.6×10^{-9}
Skin	3.100	1.0×10^{-7}	310×10^{-9}
Gall bladder	0.015	1.0×10^{-7}	1.5×10^{-9}
Tendon	0.050	0.7×10^{-7}	3.5×10^{-9}
Muscle	11.20	0.65×10^{-7}	730×10^{-9}
Red & white cells	1.05	0.65×10^{-7}	69×10^{-9}
Brain	0.502	0.2×10^{-7}	10×10^{-9}
Gut	3.6	0.09×10^{-7}	32×10^{-9}
Plasma	1.0	0.05×10^{-7}	5×10^{-9}
Total	25.446	.....	2276.5×10^{-9} gm or ~ 23% of total injected

* 10 μg of stable gold administered intravenously to a mouse in the form of gold sodium thiosulfate.

Mouse sacrificed 30 days after administration, tissues wet ashed and irradiated in the Hanford pile.

Subsequently the gold was removed by radiochemical methods, and its half life and beta-ray energy verified and counted in duplicate samples.

TABLE 4

RELATIVE RADIOACTIVITY OF IRRADIATED BLOOD ASH FROM A PATIENT WITH LYMPHOID LEUKEMIA
(One week after exposure to neutrons)

Tissue	Estimated ash wt used in determination (mg)	Relative activity* mg of ash wt
Red cells	114	1
White cells†	8	11
Plasma	280	0.2

* Mean of measurements on two samples.

† The white cells were prepared by centrifuging with beef albumin.

These considerations and experimental data indicate that microanalysis of tissue constituents by induced radioactivity may become a useful technique for the determination of ultramicro amounts of a number of elements. It is expected that the technique will play an important role not only in tracer biochemistry but in plant nutrition, pharmacology, and toxicology as well.

TABLE 5

DISTRIBUTION OF GOLD IN HUMAN BLOOD FROM A LEUKEMIC PATIENT

	Estimated wet mass in body (gm)	Gm of Au^{197}/gm of wet mass	Total Au^{197} in circulation of person (gm)
White cells	130	11×10^{-8}	14.3×10^{-6}
Red cells	2,600	0.4×10^{-8}	10.5×10^{-6}
Plasma	2,650	0.07×10^{-8}	18.5×10^{-6}

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TECHNICAL PAPERS

Creation of a "σ" Meson by a Highly Ionizing Nucleus in the Cosmic Radiations[1]

J. J. Lord and Marcel Schein

Department of Physics, University of Chicago

A 100-μ-thick boron-loaded Ilford C2 plate was exposed to the cosmic radiation through the use of free balloons which remained at altitudes corresponding to pressures between 4 and 6 cm of Hg for 11 hrs.

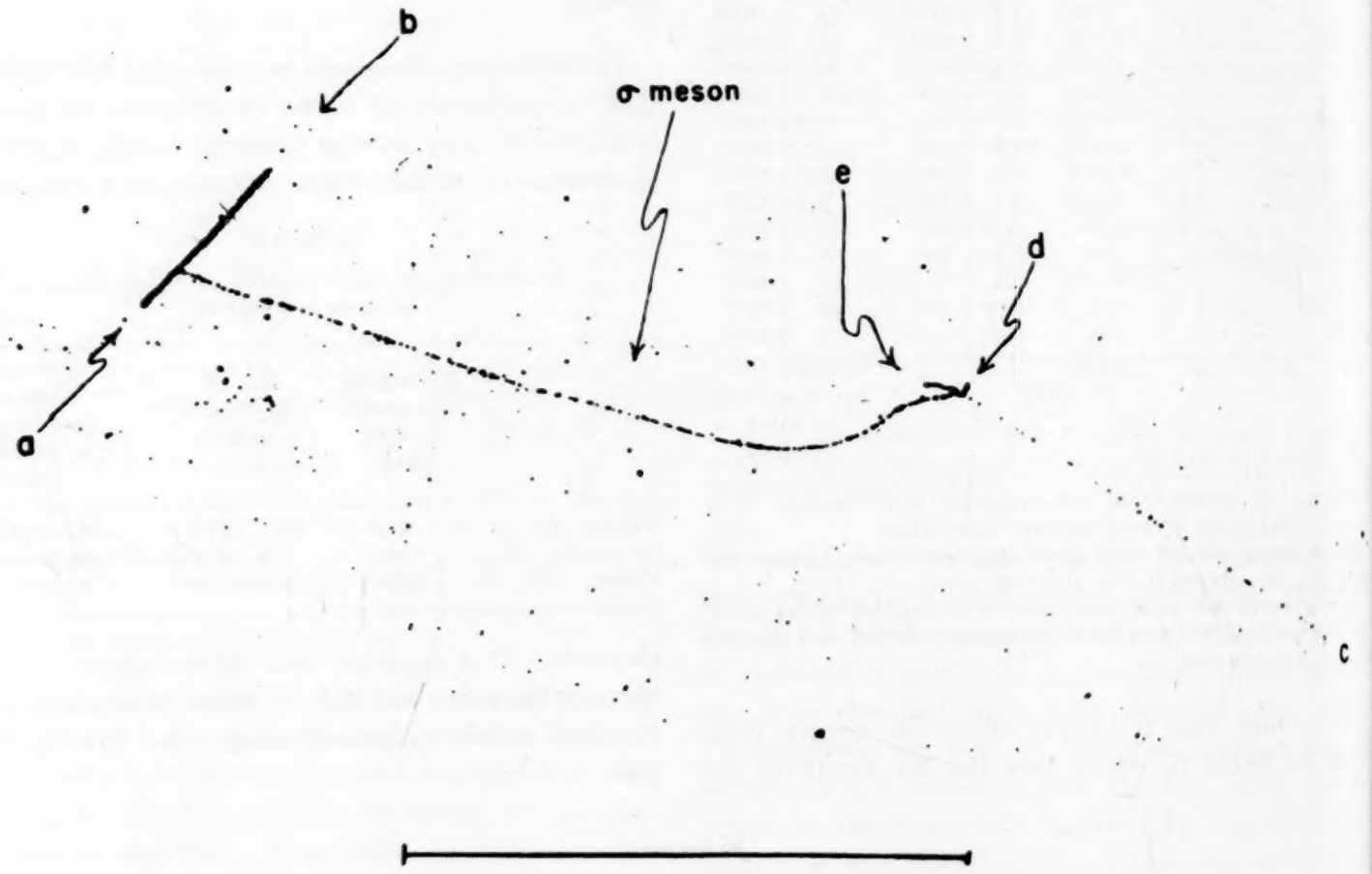

FIG. 1.

The mosaic of microphotographs in Fig. 1 shows an example of an unusual case of the production of a "σ" meson in the emulsion of this plate. The elementary act in which this meson was produced differs from those found by Powell and his collaborators (*2*).

A column of silver grains passes steeply (64°) from the top of the emulsion (a) completely through the emulsion and into the glass backing at (b). At a point on this column 26 μ from the upper surface, a "σ" meson originates and travels 158 μ, where it stops and is captured, producing a nuclear disintegration in which the visibly ionizing particles (e), (d), and (c) are emitted. Fig. 2 is a drawing in which the tracks in this event have been projected on the plane defined by the tangent to the meson track at the point of creation and the silver column from (a) to (b). The grain densities of sections (a) and (b) are considerably greater than those corresponding to protons or alpha particles capable of creating a meson of mass energy which is known from measurements with the synchrocyclotron in Berkeley, California, to be 143 mev. Section (b) of the column appears to be slightly more dense than (a). This small difference, however, may be due to a loss in resolving power of the microscopic system when viewing grains at greater depths beneath the surface of the emulsion. An upper limit to the difference in the grain densities above and below the point at which the meson is created is certainly less than 10%. The measured deviation of the

[1] Assisted by the joint program of the Office of Naval Research and the Atomic Energy Commission.

column from (a) to (b) is less than 1°, which is about the deviation expected for a straight track of 110 μ due to emulsion distortions in the central regions of a plate.

It seems impossible that this meson is produced in a nuclear disintegration of the ordinary type in which the only other visible tracks, (a) and (b), of nearly the same grain densities travel in opposite directions along a straight line. This strongly suggests that the track from (a) to (b) is due to a single particle passing through the emulsion which interacts with one of the

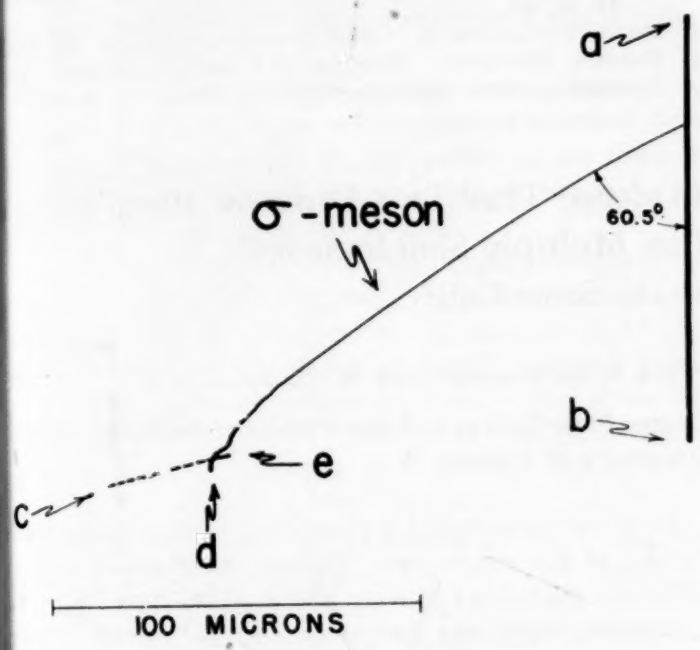

FIG. 2.

nuclei in this emulsion to create a meson. This is further augmented by the existence in this emulsion of several other heavy nuclei tracks of the same character as reported previously (*1*). This was shown by tracing the passage of 8 of these particles down through a 0.325-cm thick lead plate and into a similar photographic emulsion. Two of these were followed on through an additional 3.9 cm of lead into another photographic emulsion.

The track from (a) to (b) in Fig. 1 could not be traced through the 0.325-cm lead plate, and this places an upper limit on the range of the particle producing the meson. This, coupled with the small change of less than 10% in the ionization after the creation of the meson, shows that the particle had a maximum energy of several bev at the point where the meson was created and a nuclear charge between 7 and 20 unit electronic charges.

The absence of a large nuclear disintegration demonstrates that the meson was created in a pure nucleon-nucleon interaction. This seems to indicate that nuclei can be greatly transparent to the bombardment of stripped nuclei of energies capable of producing a meson.

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Analysis of Insect Food Habits by Crop Examination

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It has been common practice for many years to determine the food habits of birds and mammals by examination of crop or stomach contents, but there appears to have been no effort to apply the same technique systematically to the study of the food habits of insects. Recent studies, however, demonstrate clearly both the feasibility of the technique and its value in determining food habits under natural conditions.

The technique is probably applicable to all insects with chewing mouth parts, but in the studies here reported has been limited to various types of Orthoptera. In the Orthoptera, even those with graminivorous- rather than carnivorous-type mandibles (*2*), the food is not so finely divided when it reaches the crop but that much can be learned of its character from examining the fragments. Whether leaf fragments are from forbs or narrow-leafed plants can readily be determined by the character of the epidermal cells of the plant fragments found in the crop. Even those grasshoppers that feed exclusively on grasses and have graminivorous mandibles swallow relatively large bits of grass. Some plant fragments may be quite accurately identified—pollen grains, for example. Fragments of insects permit various degrees of identification: scales of Lepidoptera may be intact; wing fragments of smaller insects may show characteristic patterns of venation; or mouth parts and leg parts may be distinguishable. In other words, the natural diet of an insect species may be determined, at least qualitatively, from the examination of collected specimens. This means that one need not have recourse to laborious methods of experimental testing, at least for preliminary studies of food selection, and in some cases this technique may prove entirely adequate for both quantitative and qualitative determinations of food habits. Since field observation has not proved a successful means of judging food choice and since such observation has led to many errors, it appears probable that the method of crop analysis may prove a valuable guide to food habits of many species. It has already yielded significant results for certain orthopterans.

The feasibility of this technique is due to the fact that the food eaten by an orthopteran accumulates in the thin-walled expansible crop, where it undergoes little digestion before passing into the next division of the digestive tract. The esophagus in the Orthoptera merges directly into the crop, which may or may not be rather definitely

[1] Prof. Isely died December 30, 1947. This report was prepared by the junior author from his notes and supplementary observations.

separated by a constriction from the next section, the proventriculus. In the Gryllidae and Tettigoniidae (e.g., *Conocephalus*, see Fig. 1) the constriction is quite evident; in the Acridiidae it is less noticeable. In either case, however, food accumulates in the crop in a state of incomplete mastication. Examination of the crop contents may be most simply carried out by pulling off the head of the freshly killed insect. The digestive tract, at least the anterior part, will remain attached to the head. In crickets, katydids, and meadow grasshoppers the tract usually breaks at the constriction forming the posterior boundary of the proventriculus. In the short-horned grasshoppers practically the entire tract may be pulled out with the head. In either case, the crop may be opened at the anterior or posterior end and its contents pushed out. Teased apart in a drop of water on a microscope slide, the contents are ready for examination. The crop contents of specimens collected years before can be examined successfully if a little more care is observed. The contents of the crop, either from fresh or dried material, if placed under a sealed cover glass in 40 parts of 10% formalin and 60 parts of glycerine, can be studied at leisure.

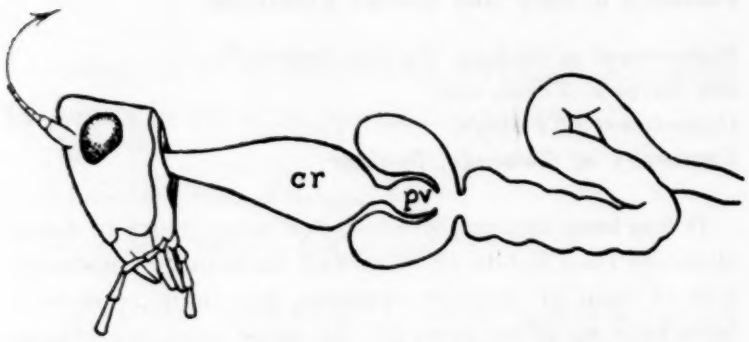

FIG. 1. Head and digestive tract of *Conocephalus fasciatus*, approximately 3 times natural size. The crop (cr) is distended as it is when filled. When the tract is pulled out with the head, it usually breaks at the indentation just posterior to the proventriculus (pv).

The value of crop analysis is well illustrated by the fact that studies recently carried out on several species of meadow grasshoppers (Conocephalinae) show conclusively that insects constitute a part of their normal diet. Certain other members of the Tettigoniidae, particularly decticids, are known to be carnivorous (*3*). The carnivorous habits of the meadow grasshoppers, on the other hand, while known, have been considered aberrant modifications of the normal feeding behavior (*1*). These first studies, which are to be reported in extended form elsewhere, show further that the vegetative parts of plants are rarely, if at all, eaten by these Conocephalinae. These insects subsist on flowers, pollen, and seeds of grasses, in addition to insects, normally deriving little if any food from the leaves of either the grasses or the broad-leafed plants among which they live. Inasmuch as it has been assumed, largely on the basis of analogy, that meadow grasshoppers exert significant pressure on meadow vegetation (*4*), the method of crop analysis has in this case demonstrated that the biotic role of this group of insects is quite different from that which has been assumed for it for many years. These species, which we have believed harmful, may, on the basis of these studies, be considered beneficial, or at least neutral, in their ecological role. An expansion of this technique to the study of the food habits of other species may yield equally interesting and significant results.

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Evidence That Two Different Plant Viruses Can Multiply Simultaneously in the Same Cell[1]

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It is well known that a plant may harbor two or more viruses at the same time. Indeed, infection of a plant with two nonrelated viruses, which alone cause only mild symptoms, sometimes results in a severe disease. Thus, mild tobacco mosaic and potato mottle viruses together produce a serious disease of tomato known as streak (*7*). It has been presumed, but not proved, that two such nonrelated viruses may occupy the same cell. Experiments reported here demonstrate the presence of inclusions of both tobacco mosaic and tobacco etch viruses in a large number of cells of doubly infected tobacco plants. Since these inclusions are closely associated with the respective viruses, their presence together indicates that the viruses increased simultaneously in the same cell.

The type strain of tobacco mosaic virus, which we used, forms abundant hexagonal crystals in the cytoplasm of its host. The mild strain of tobacco etch virus likewise produces crystals, often plate-like, but easily differentiated from those of tobacco mosaic virus, being different in size, form, and location. They occur characteristically in the nuclei but can sometimes be seen in the cytoplasm. Such inclusions were first described for the severe strain of tobacco etch by Kassanis (*4*).

The crystalline inclusions are usable for identifying tobacco mosaic and tobacco etch viruses within cells. Each of these viruses forms, in the cytoplasm, amorphous bodies which McWhorter (*6*) has designated as *viroplasts*. The viroplasts vary in structure; those of tobacco mosaic cannot always be distinguished from those of tobacco etch. They are not, therefore, readily usable for identifying the respective viruses within cells.

[1] Aided by a grant from the National Foundation for Infantile Paralysis.

[2] Senior Research Fellow, University of Pittsburgh, from January to May, 1948.

Nicotiana tabacum L. and *N. sylvestris* Spegaz. and Comes were used as host plants for this study. They were inoculated with the two viruses either simultaneously or at intervals of one and four days. Controls consisted of plants inoculated with only one virus. The macroscopic symptoms of tobacco etch usually developed from one to three days before those of tobacco mosaic. Symptoms of both viruses were easily seen in doubly inoculated plants during onset and up to two or three weeks after inoculation. Later, symptoms were predominantly those of etch, doubly infected plants being distinguished from those infected with etch alone merely by a slight reduction in size.

Slides for microscopic examination were prepared by cutting thin slices of tissue, with trichomes attached, from the veins and edges of leaves, and mounting the tissue in 0.85% NaCl. Cytological examinations were made on the 11th and 40th days after inoculation.

The size and location of leaves wherein complete expression of cytological symptoms regularly occurred were determined for both viruses by examination of control plants. Corresponding leaves of doubly infected plants were then studied to determine the distribution of the two viruses in individual cells. The first cytological examination revealed the presence of crystalline inclusions of both viruses in every observed integumentary cell of such leaves from simultaneously inoculated plants. This was not entirely true for corresponding leaves of plants inoculated first with one virus and four days later with the other. In such plants, cells of leaves near the point of inoculation showed inclusions dominantly or entirely of the primary virus only. Cells of leaves higher up the plant, however, nearly always showed inclusions of both the primary and the challenge virus.

When the plants were reexamined 40 days after inoculation, again nearly every observed cell of appropriate leaves showed crystalline inclusions of both viruses. In many cases, leaves near the tops of the plants showed only tobacco etch inclusions while those lower down the plant showed both. This observation suggests that inclusions of etch develop sooner than those of mosaic in old plants and may help explain the dominance of etch symptoms.

The hexagonal plates of tobacco mosaic are known to be closely associated with tobacco mosaic virus. Likewise, the intranuclear crystalline inclusions of tobacco etch are closely associated with tobacco etch virus. Since it is very unlikely that the materials composing these inclusions were formed in distant cells and transferred in toto to the many cells where they were found occurring together, the evidence indicates not only that the two viruses were present in the same cells, but also that they multiplied in the same cells.

Experiments reported above gave no evidence of interference between tobacco mosaic and tobacco etch viruses, such as that reported between the severe strain of tobacco etch virus and potato Y virus (*1*). The interference phenomenon is well established for bacteriophages (*2*) and for certain viruses that cause disease in man and other animals (*3, 8*). It has been demonstrated for plant viruses only in the case cited above. However, the literature on interference occasionally confuses this phenomenon with *cross protection* such as was observed by Kunkel (*5*) between tobacco and aucuba mosaic viruses. It seems worth while to point out here that cross protection, in contrast with interference, consists of the protection afforded a plant by virtue of a previous infection with a closely related virus strain. Nonrelated viruses do not ordinarily give such protection.

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Catheterization of the Coronary Sinus, Right Heart, and Other Viscera With A Modified Venous Catheter

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Medical Division, Army Chemical Center, Edgewood, Maryland

A technique of coronary sinus catheterization (*10*) has made it possible to study coronary blood flow and myocardial metabolism in intact dogs (*6, 7, 11*) and has been recently applied to similar studies in man (*2, 3*).[2] More recently a modified venous catheter has been devised to meet several of the special problems encountered in this procedure. In extensive trials in man, with Bing and his associates (*3*), as well as in dogs, the modified catheter described in this report appeared to facilitate catheterization of not only the coronary sinus, but also other regions in the heart and visceral veins.

The venous catheter now most generally used was designed by Cournand and Ranges (*4*), some years following Forssman's original description of right auricular catheterization in man (*8*). It is 100 cm long, of the ureteral type, with a woven shellacked nylon core covered with a heavy X-ray-opaque plastic coating and with a

[1] Present address: Peter Bent Brigham Hospital, Boston 15, Massachusetts.

[2] The application of this technique, together with the nitrous oxide blood-flow method of Kety and Schmidt (*12*), to the measurement of coronary blood flow in man, has been a joint project undertaken by Bing and his co-workers at Johns Hopkins University Medical School, in cooperation with the authors and with Eckenhoff and his associates at the University of Pennsylvania Medical School (*2*). To all of these, the authors are deeply grateful for their collaboration and interest, and to Normal C. Jeckel and Edward W. Grant, of the U. S. Catheter and Instrument Corporation, for their help and advice.

curved tip terminating in a single straight opening or "eye." (A catheter 125 cm in length is usually necessary for Dexter's technique of sampling blood from the pulmonary capillary bed *5*.)

Using this standard catheter, it has often been difficult to obtain blood samples from the coronary sinus and cardiac veins. Probably a vessel wall or valve leaflet has occluded the single terminal eye as suction has been applied with the sampling syringe, even though fluid could always be freely injected through the catheter. This difficulty was sometimes encountered in drawing blood from other regions, such as the hepatic or renal veins or the right ventricle, and was greater with smaller catheters (No. 6 to No. 8F). However, for avoiding coronary venous obstruction and possible intimal damage (*11*), these smaller catheters have been desirable. Pressure recordings have also been damped sometimes, apparently by the single terminal eye impinging upon a closely confining vessel wall or even upon the endocardial surface.

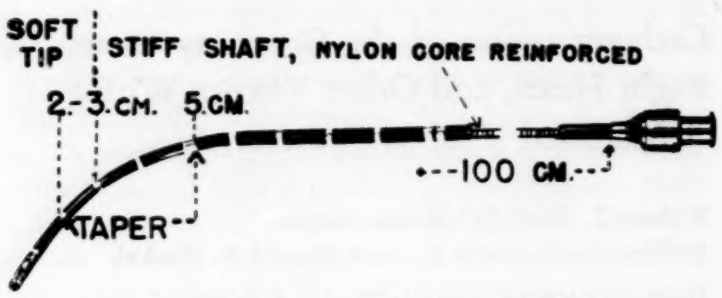

FIG. 1. Bird's-eye catheter (tapered).

The standard venous catheter of Cournand has, therefore, been modified by the addition of two small side eyes, or what we have termed "bird's-eyes," with shallow grooves in the outer surface of the catheter leading forward from the side eyes to the usual terminal eye (Fig. 1).[3] These features have prevented effective suction from being applied to a vessel wall, endocardium, or coronary-sinus valve leaflet during sampling, and no difficulties in withdrawing blood samples from any visceral vein have been encountered. Reasonable pressure recordings have been obtained which, if anything, have been less damped than those previously obtained in the right auricle and coronary venous system with the standard catheter. Any possible local trauma or cardiac arrhythmia arising from suction of intima or endocardium against the usual tip should also be minimized by the multiple eyes which break any suction against the modified catheter tip.

The "bird's-eyes" have been placed only 2 mm behind the tip, allowing accurate localization of blood samples and pressure recordings. The whole tip, including the grooves, has been given several extra coats of plastic finish to ensure a smooth atraumatic surface.

As a further modification, a tapered tip, also illustrated in Fig. 1, has proved valuable in catheterizing the hepatic and renal veins, as well as the coronary venous system of dogs and man (*9*). A No. 9F shaft with a gradual taper to a No. 7½F from a point 5 cm to 2 cm from the tip, or a No. 8F tapered to a No. 6½F tip, was found to be most advantageous. The nylon core has been doubly woven to a point 3 cm from the tip. This tapered catheter has combined the advantages of a relatively large, stiff, nonbuckling, easily manipulated, and easily visualized catheter shaft with a smaller, more flexible, less traumatic, and nonobstructing tip. This modification has facilitated controlled gentle insertion of the catheter into the coronary sinus. As an alternative, however, a No. 7 or No. 8F modified "bird's-eye" catheter without a taper has been used in man, often with a stylet inserted to within 3–4 cm of the tip to lend sufficient stiffness to the catheter shaft for controlled insertion (*3*). The stylet has then been removed as soon as the catheter had been successfully inserted into the coronary sinus.

The tapered catheter has a uniform No. 7 or No. 6? bore throughout its entire length, providing a minimal dead-space volume. Occurring at a known distance from the tip, the taper provided a landmark under fluoroscopy for direct estimation of the depth of insertion of the catheter into the coronary venous system.

Earlier workers were discouraged from using a catheter with side eyes or multiple eyes by the tendency for blood clots to form and obstruct the catheter lumen. With the present modified catheter this has been avoided by keeping the catheter thoroughly washed out with saline between samplings. A continuous saline infusion had to be maintained in addition to an injection of 5–10 cc of saline after each observation or sample. The grooves in the outer surface of the modified catheter tip prevented complete obstruction of either side eye by a vessel wall, so that the saline infusion constantly washed all 3 openings free of blood which might otherwise stagnate and clot. It was not necessary to add heparin to the continuous infusion, although several investigators add 20 mg/liter as an extra precaution against clotting. Others prefer to fill only the dead space of the catheter with the proper amount of heparin just before drawing each blood sample, so that the patient himself will receive no heparin. Traces of this heparin then appear to cling to the sides of the catheter lumen during the ensuing washout and sampling in sufficient quantity to prevent clotting until fresh saline infusion can be re-established. Tiny platelet thrombi were sometimes found in the side eyes after long procedures in man, but usually did not interfere with sampling.

In dogs, which have a more active clotting mechanism than man (*1*), an additional routine for preventing clotting in the catheter was often necessary (*11*). This might also be of value in man. The routine consisted of baking the catheter dry following the usual chemical sterilization and dipping the tip in full-strength heparin (Liquamine, Lilly) for an hour just before use. After proper drying the hydrophilic plastic coating absorbed enough heparin to act as an effective local surface anticoagulant.

Baking (at 110–120° C dry heat for 1–2 hrs) also stiffens the catheter, making it easier to manipulate and

[3] Available from the U. S. Catheter and Instrument Corporation, 334 Bay Street, Glens Falls, New York.

urately and probably less traumatically (*5*). Excessive eat (over 125° C) or too frequent baking shortens the ife of the catheter. The only alternative to occasional aking, when the catheter finally becomes too limp to ontrol, is the use of a stylet to lend sufficient stiffness or controlled insertion, as described above.

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A Modified Photoelectric Apparatus for Permeability Studies[1]

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For a number of years the author has been using a photoelectric technique for measuring the permeability of erythrocytes similar to that described by Parpart (*3*). Most of the experiments have involved hemolysis studies of chicken erythrocytes. Since the rate of hemolysis may be influenced by a number of different factors (e.g., Jacobs, *2*) it was decided to use swelling measurements only as an indication of permeability changes. The author has experienced much more difficulty in obtaining measurable light changes when chicken erythrocytes swell, however, than when mammalian erythrocytes are used.

It was thought that perhaps greater sensitivity could be obtained using light of a wave length corresponding to the region of the spectrum which is maximally absorbed by hemoglobin. Consequently, the light was passed through a green filter[2] before going through the erythrocyte suspension. This, however, decreased the light transmission to such an extent that the current produced by the photronic cell was too small to give a measurable deflection of the galvanometer. A photoelectric call and amplifier were substituted for the photronic cell with satisfactory results. A photograph of the photocell-amplifier unit[3] is shown in Fig. 1 and a diagram of the circuit, in Fig. 2.

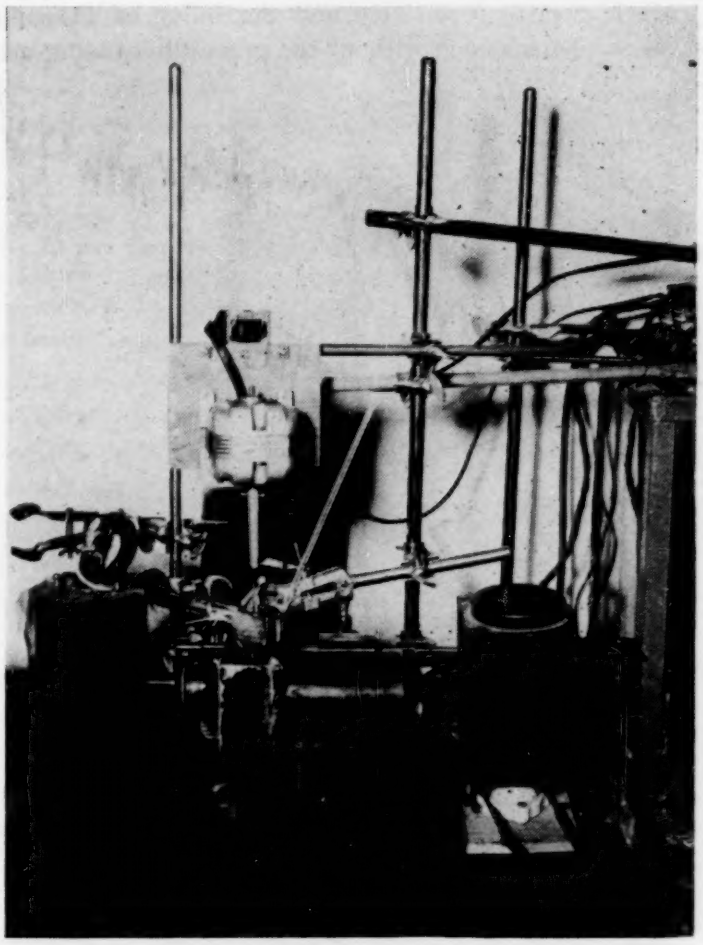

Fig. 1

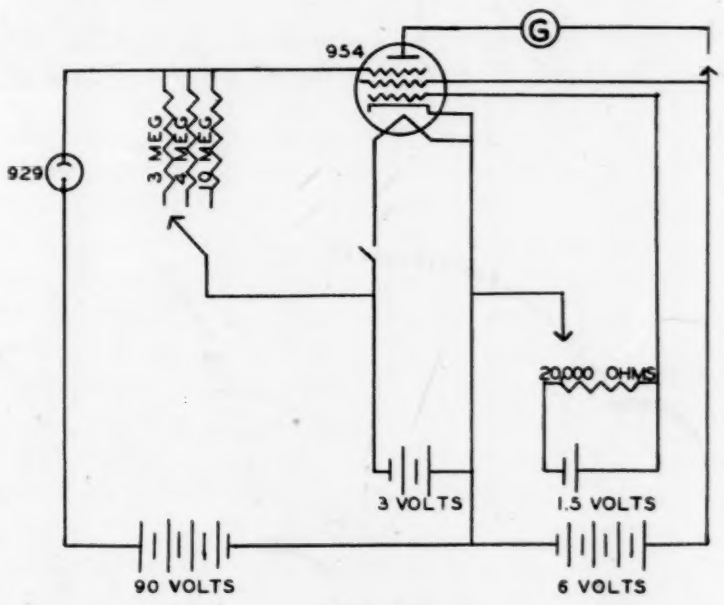

Fig. 2

[1] This work was made possible by grants from the U. S. Public Health Service and from the Faculty Research Fund of the University of Oklahoma.

[2] Corning glass filter #4010, which has maximum transmission at 525 mμ.

[3] The author is indebted to Hans Weltin, Department of Physics, University of California, Santa Barbara, for the design and construction of this unit.

Much greater sensitivity and flexibility of the apparatus can be obtained without the green filter, using more

FIG. 3. The effect of concentration on swelling of chicken erythrocytes in 0.3 M glycerol in Ringer Locke. A—0.15 cc of blood; B—0.18 cc of blood; C—0.20 cc of blood; D—0.10 cc of blood (medium sensitivity on amplifier).

concentrated erythrocyte suspensions. It can be seen from the circuit diagram that the amplifier has three degrees of sensitivity. In addition, an Ayrton shunt is placed in the galvanometer circuit which adds another means for varying the sensitivity.

Figs. 3 and 4 illustrate the performance of the apparatus when used without the filter. In obtaining Figs. 3A, B, and C and 4B the shunt was set to give next to maximum sensitivity and the amplifier to give maximum

FIG. 4. The swelling of human erythrocytes in 0.3 M glycerol in Ringer Locke. A—0.06 cc of blood (medium sensitivity on amplifier); B—0.10 cc of blood (maximum sensitivity on amplifier).

sensitivity. Figures 3D and 4A were obtained with the shunt on next to maximum sensitivity and the amplifier on medium sensitivity. Figure 3 shows the effect of varying the concentration of chicken blood added to 10 cc of 0.3 M glycerol in Ringer Locke. The first 15 sec are recorded; readings were then taken at 15-sec intervals. In spite of the difference in deflection with the different concentrations, half of the total deflection in each instance is reached in approximately 1¼ min. Figure 4 is a continuous recording of the swelling of human erythrocytes in 0.3 M glycerol in Ringer Locke. In both A and B the deflection was too great to record the complete curve on the camera. A comparison between Figs. 3 and 4 demonstrates the greater galvanometer deflection which can be obtained using mammalian erythrocytes.

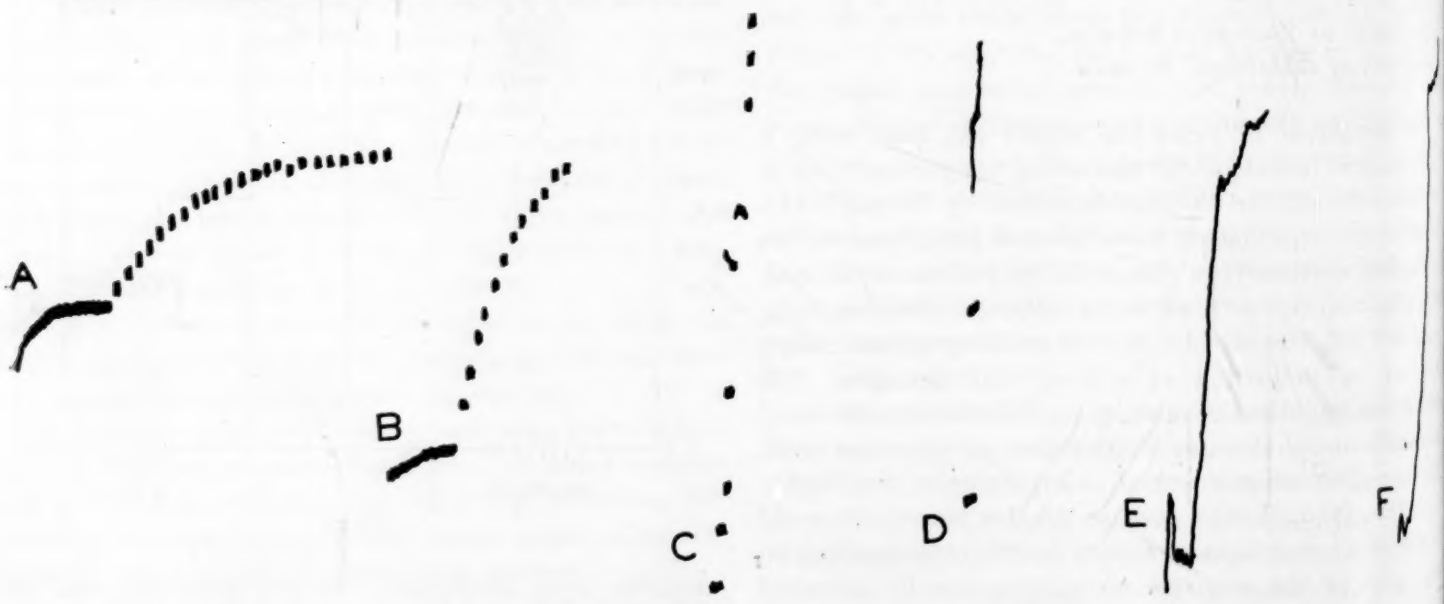

FIG. 5. The effect of standing at 37° C on the amount of galvanometer deflection obtained with chicken (A–D) and human (E, F) erythrocytes swelling in 0.3 M glycerol in Ringer Locke. A—0 hrs; B—3 hrs; C—6 hrs; D—19 hrs; E—½ hr; F—12 hrs.

Fig. 5 is included to illustrate a possible source of error

which must be carefully considered in making measurements of swelling.[4] In a preliminary paper (*1*) it was pointed out that untreated chicken erythrocytes, after standing for several hours at 37° C hemolyze more rapidly than they do during the first few hours at this temperature. Fig. 5A–D illustrates that the galvanometer deflection increases as chicken erythrocytes stand at 37° C. At zero time the whole swelling curve can easily be recorded on the 12-cm bromide paper, but several hours later the deflection of the galvanometer becomes so much greater that only the first portion of the curve can be recorded. Figs. 5E and F show that no comparable change is observed when human erythrocytes stand at 37° C.[5]

References

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Comments and Communications

Blood Changes Due to Ammonia Inhalation?

We have read the recent article by Schmidt and Vallencourt entitled "Changes in the Blood Following Exposure to Gaseous Ammonia" (*Science*, November 19, p. 555). There are several serious errors apparent in this work which should be pointed out.

At the meeting of the American Public Health Association in Boston last November, we presented results of a study involving 30-min exposures of 7 human subjects to 500 ppm of anhydrous NH_3 gas. A description of the data was submitted for publication in October 1948 and will soon appear in a scientific journal.

A concentration of 500 ppm was used; therefore our results can be compared to those of Schmidt and Vallencourt. We selected ½-hr exposures since Henderson and Haggard (*Noxious gases*, New York: Reinhold, 1943, p. 126) reported that the maximum allowable concentration for a ½- to 1-hr exposure is 300 to 500 ppm.

All 7 subjects experienced irritation of the nose and throat immediately, and, in some, the irritation persisted for as much as 24 hrs. It is surprising that the subject reported in Schmidt and Vallencourt's paper did not experience marked irritation of the nose and throat after 4 hrs' exposure to a mean concentration of 545 ppm.

The authors failed to report the details of the exposure chamber and the subject's activity during the exposure. It seems unusual to maintain a gas concentration so well in an ordinary room unless the dilution rate is close to the rate of gas evolution. Since only two air analyses were made over a period of 4 hours and these were "grab samples" (L. Silverman, *Industrial air sampling and analysis*, Chem. and Tox. Bull. No. 1, Pittsburgh: Industrial Hygiene Foundation, 1947), it is quite possible that the actual concentration may have varied widely.

The values presented in the authors' Table 1 may be questioned in several respects. The most serious discrepancy appears to be in the blood-NH_3 (mg %) values (column 3). If one assumes a minute volume of 20 l[1] and an ammonia concentration of 545 ppm (mean of two determinations made by the authors) and, finally, that all ammonia is retained in a blood volume of 5 liters, then the values shown below are obtained. These results neglect ammonia conversion to other nitrogenous compounds and are presented below in comparison to the authors' values.

TABLE 1

Time (hrs)	Authors' NH_3 (mg %)	Calculated NH_3 (mg %)
Normal	00.0	00.0
1	12.1	8.7
2	21.9	17.4
3	27.9	26.2
4	36.4	34.9

From this table, it appears that the authors have found more ammonia than could theoretically be retained. Possible explanations might be either greater respiratory minute volume or lower blood volume, but these could hardly vary widely enough to explain the discrepancy. The invalidity of the assumption that all inhaled ammonia is retained is evident from our data, which show that the amount of ammonia retained decreases with time until after 30 min only 20 to 30% of the inhaled concentration is absorbed, as measured by frequent exhaled-air analyses. The data on blood ammonia presented by Schmidt and Vallencourt are rendered even more incredible by reference to Peters and Van Slyke (*Quantitative clinical chemistry* Vol. 1, 2nd ed. Baltimore: Williams and Wilkins, 1946). The method used was apparently not accurate enough to detect normal levels of blood ammonia, which, with proper methods, is of the order of 0.004 to 0.05 mg % (reported by Schmidt and Vallencourt: 00.0 mg %). It is well known that ammonia concentrations multiply rapidly in drawn blood unless rigid precautions are taken. On the other hand, the blood level *in vivo* is kept very near to 0 by the extraordinary efficiency with which ammonia is converted to amide nitrogen in the tissues and to urea in the liver. Ammonium salts are readily absorbed from the gastrointestinal tract; however, even large doses evoke but a slight transitory rise in blood ammonia, the ammonia being rapidly excreted as urea. Administration of 10 to

[1] This represents the mean value of sedentary subjects exposed to 500 ppm in our study and represents the increase produced by NH_3 over normal values of 8–12 liters.

[4] Bacteriologically sterile techniques were observed except during the few minutes when the actual swelling measurements were made.

[5] All records were obtained using a recording camera placed 1 m from a Leeds and Northrop Type R galvanometer with a sensitivity of 0.003 μa/mm at 1 m and a period of 3 sec. A Kipp and Zonen torsion string galvanometer has also been used with satisfactory results. The temperature was 37° C in all cases. Figures 3–5 are tracings of the photographic records.

13 gms of ammonium citrate to normal human subjects raised the blood ammonia from 0.02 to 0.04 mg % to only 0.06 mg % (quoted by Peters and Van Slyke). Furthermore, ammonia is a highly toxic material. Bollman and Mann found that liverless dogs developed signs of ammonia intoxication (e.g. convulsions) when the blood level reached 2.0 mg % (*Amer. J. Physiol.*, 1930, 92, 92).

Our studies based on 30-min exposures indicated no significant deviations from normal in blood and urine nitrogen measurements.

Schmidt and Vallencourt state: "It has been known for some time that inhalation of ammonia lowered the blood pressure, but no quantitative data pertaining to this are available." Sollman (*A manual of pharmacology*, 5th ed. Philadelphia: W. B. Saunders, 1936, p. 837) states that the effect of ammonia inhalation is a rise of blood pressure, reflex in origin from stimulation of trigeminal nerve endings. Because of the reflex nature of the blood pressure effect and since our results showed that ammonia retention decreases with time, one would expect the influence of NH_3 on blood pressure to be greatest in the first 30 minutes. We found no consistent change at the concentration used, which agrees with the authors' finding, but it seems very unlikely that a later fall in blood pressure should be attributed to ammonia. Schmidt and Vallencourt are curiously indefinite on their "quantitative" observations of blood pressure. Whether the pressure reported is systolic or diastolic is not stated, and it is impossible to generalize about blood pressure responses from a single experiment on one individual. In view of the steady decrease in pressure shown by the authors for three hrs' exposure, it is curious that further observations were not made, since the decline at 3 hrs was approaching significantly hypotensive levels.

LESLIE SILVERMAN and JAMES L. WHITTENBERGER
Harvard School of Public Health, Boston

On New Nicotinolytic Compounds

In previous papers (C. Heymans and G. R. de Vleeschhouwer. *Arch. int. Pharmacodyn. Thér.*, 1948, **75**, 307, 413) it has been demonstrated that the diethyl-amino-ethyl ester of phenyl-cyclopentane carbonic acid (parpanit) is a very active nicotinolytic agent. Intravenous injections of 20–30 mg/kg of parpanit indeed suppress all toxic actions of high doses of nicotine.

The present experiments were undertaken with another new synthetic compound: N-diethyl-amino-ethyl phenothiazine (diparcol). Some general pharmacological properties of this substance were already studied by Bovet, Fournel, and Charpentier (*Thérapie*, 1947, **2**, 115) and Gordon (*Nature, Lond.*, 1948, **162**, 146).

Our experiments (*Commun. Soc. Biol. Montevideo*, November 25, 1948) were performed on chloralosed dogs. Intravenous injections of 15–30 mg/kg of diparcol protect completely against 100–200 lethal doses of nicotine. No cardiac slowing or irregularities, cardiac fibrillation, changes in blood pressure, bronchospasms, hyperperistalsis, convulsions or muscular fibrillations, salivation, or paralysis of the respiratory center occurs after intravenous injections of 100–200 LD of nicotine in dogs pretreated with diparcol. Thus, this new compound is also a very active nicotinolytic agent.

Parpanit and diparcol are not only powerful nicotinolytic substances but also synapticolytic, parasympatholytic and anticonvulsant agents. These compounds also very actively protect against high doses of acetylcholine, pilocarpine, diisopropyl fluorophosphate (DFP), strychnine, and Metrazol.

These experimental observations may have some important practical applications.

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University of Montevideo, Uruguay

Nazi Persecution of Scientists

In connection with Professor Muller's letter to the Soviet Academy of Sciences (*Science*, October 22, p. 436), I think it would be helpful to call the attention of every American scientist, Army and Navy officer, and congressman, to a few sentences in *Goebbels' diaries* (New York: Doubleday, 1948).

On page 361 Goebbels tells of an occasion on which he, Frick, and Rust were guests of the Fuehrer. He wrote, "Their comments and remarks were so idiotic as to reveal how completely out of the picture they really are. They delivered themselves of stupid phrases . . . ." The important point is that Rust was the Nazi Minister of Education and, as Lochner notes, he had been an inmate of an insane asylum! He was the one chosen to persecute the scientists and university leaders, causing them to flee from Germany for their lives.

This seemed to be a good idea at first, but on May 12, 1943, things were going badly for the Germans in the air and on the sea. The Allies were using new discoveries in physics which were paralyzing the German planes and submarines. And so, on p. 375, one finds Goebbels regretting that Max Planck had been so antagonized. As he said, "It is the fault of Rust and is irremediable . . . . The mediocre talents in the Reich Government are a wall between the Fuehrer and many sectors of public life." In his devotion to his Fuehrer, Goebbels tried to make him out as a would-be patron of science, ignoring the fact that he had appointed a miserable quack as his private physician.

On p. 378, speaking of the critical situation of the submarines in the face of the new detecting devices developed by Allied physicists, Goebbels wrote, "Our technical development both in the realm of submarines and of air war is far inferior to that of the English and the Americans. We are now getting the reward for our poor leadership on the scientific front, which did not show the necessary initiative to stimulate the willingness of scientists to co-operate. You just can't let an absolute nitwit head German science for years and not expect to be punished for such folly."

This paragraph might well be read and re-read now at home and abroad. In times of peace, baiting scientists and great men and putting them in their place is great fun for politicians but Goebbels has told us how disastrously this policy pays off when war comes.

WALTER C. ALVAREZ
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Book Reviews

Methods of psychology. T. G. Andrews. (Ed.) New York: John Wiley; London: Chapman and Hall, 1948. Pp. xiv + 716. (Illustrated.) $5.00.

Many instructors have long desired a systematic text to facilitate greater emphasis on methodology in the training of undergraduate psychology students. This book, which deals with methodology in many areas of psychology, was written by specialists in each area. The editor recognizes certain limitations in terms of omissions, both in the material presented and in areas not represented, such as industrial psychology.

After an introductory chapter on variables, controls, experimental design and the like, methodology in each of several areas is presented. Consideration is given to various aspects of learning, psychophysics, perception in various sense modalities, affection, motor functions, personality, social behavior, child development and others.

The things an instructor might like to find in the discussion of any one area, such as studying human thinking, might well include the following: sample problems, experimental designs for the problems, outlines of methods with apparatus including diagrams and controls, references to more complete details in published reports, methods of treating data with sample tabular arrangements and graphs, and some guidance for critical interpretation of results. No chapter of this book may completely satisfy all the requirements laid down by the critical reader. Some are very well done but others are poor in terms of adequate treatment of methods in the area. For instance, the reviewer considers the discussions of "Psychophysical Methods," "Studying Proprioception," "Motivation, Feeling and Emotion," and "Studying Neuropsychology and Bodily Functions" to be among the better chapters. "Studying Vision," on the other hand, is poor and some of the other sections are only mediocre. The first chapter, on introduction to psychological methodology, could have been more complete in details and illustrations.

There are two major deficiencies in the organization of this treatise: the apparent expectation that the meagre information on experimental design and controls in the first section will transfer to the study of subsequent chapters, and the attempt in most chapters to cover too much territory, which obviously has led too frequently to skimpy treatment of experimental design, methods, apparatus, and controls. In terms of teaching methodology, the book might have been more helpful to the student if each chapter had included brief statements of types of problems and methods with references to sources where complete descriptions may be found. Then there should have been a discussion of one typical experiment including a statement of the problem, method and apparatus with experimental design, controls, organization of results and conclusions. With the present organization of the book, it is doubtful if the student will learn the requirements for planning and carrying out experimental work in more than a few of the areas.

This text, which has several excellent chapters, represents a step in the proper direction. Criticism of the materials presented undoubtedly will eventually lead to a revision with a better organization. In the meantime the book should find general use in experimental and methodology courses.

MILES A. TINKER

University of Minnesota

Principles of mathematical physics. (2nd ed.) William V. Houston. New York-London: McGraw-Hill, 1948. Pp. xii + 363. $5.00.

The first edition of Houston's book was known to teachers of theoretical physics for the clarity of its presentation and the judicious selection of material included. The second edition preserves these advantages. It is still a textbook usable in an intensive semester or a leisurely year's course, although it has been expanded and rearranged. The problems continue to be a major feature of the text and these are not routine but form a complement to the material chosen for detailed treatment. Especially useful, and rarely found in books of this type, is a chapter on the theory of vibrating systems.

It might be said that the work is incomplete and lacks coherence. If the size of the book was set in advance, however, the author has utilized the space for the most worthwhile material.

HENRY MARGENAU

Yale University

Studies of upper-air conditions in low latitudes. Part I: ***On the formation of West Atlantic hurricanes*** (Riehl); Part II: ***Relations between high- and low-latitude circulations*** (Cressman). Herbert Riehl and George P. Cressman. Chicago: Univ. of Chicago Press, 1948. Pp. vi + 103. (Illustrated.) $2.00.

Military requirements during World War II and certain unsolved problems of the general circulation in the earth's atmosphere have been a stimulus to a considerable amount of research in tropical meteorology during the past several years. Successful research in this field of meteorology requires an unusually high degree of skill in analysis and interpretation because of the vastness of the geographical region under consideration, the paucity of the available data, and the complexity of the phenomena under study. The authors have been prominently associated with recent research in this field, and their report, though plainly not a comprehensive summary of knowl-

edge concerning tropical meteorology, clarifies several important aspects of low-latitude weather, emphasizes the importance of upper air analysis, and stresses the interrelationship between tropical weather phenomena and extratropical circulation patterns.

In Part I the structure of tropical hurricanes is compared with the less spectacular, but climatologically more significant, tropical disturbances, and the circumstances attendant upon the transition from one to the other are discussed. An explanation for the generation of cyclonic vorticity is presented which differs from that usually accepted in middle latitudes. The importance of an overlapping between middle- and low-latitude disturbances is discussed and illustrated with synoptic examples.

Part II is restricted to the definition, description, and illustration of typical circulation patterns during the summer months. The importance of the interrelation between tropical and extratropical disturbances is discussed.

The report is an excellent example of the results which can be obtained in a highly specialized field by research scientists who are thoroughly familiar with current and past research in other fields of meteorology.

THOMAS F. MALONE
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Scientific Book Register

CONDIT, IRA J. *The fig.* Waltham, Mass.: Chronica Botanica; New York: Stechert-Hafner, 1947. Pp. xv + 222. (Illustrated.) $5.00.

CORNER, GEORGE W. (Ed.) *The autobiography of Benjamin Rush: his "Travels Through Life" together with his Commonplace Book for 1789–1813.* Princeton, N. J.: Princeton Univ. Press, 1948. Pp. 399. (Illustrated.) $6.00.

CURTIS, WINTERTON C., and GUTHRIE, MARY J. *Laboratory directions in general zoology.* (4th ed.) New York: John Wiley; London: Chapman & Hall, 1948. Pp. viii + 236. (Illustrated.) $2.00.

DAVIS, H. A. *Shock and allied forms of failure of the circulation.* New York: Grune & Stratton, 1949. Pp. xii + 595. (Illustrated.) $12.00.

ELLIOTT, GODFREY M. (Ed.). *Film and education: A symposium on the role of the film in the field of education.* New York: Philosophical Library, 1948. Pp. xi + 597. $7.50.

FIELD, HENRY. (Compiler.) *Contributions to the anthropology of the Soviet Union.* (Publ. 3947.) Washington, D. C.: Smithsonian Institution, 1948. Pp. vii + 244. (Illustrated.) $2.00.

KELLEY, WALTER P. *Cation exchange in soils.* New York: Reinhold, 1948. Pp. xv + 144. (Illustrated.) $4.50.

MARTON, L. (Ed.). *Advances in electronics.* (Vol. 1.) New York: Academic Press, 1948. Pp. xi + 475. (Illustrated.) $9.00.

MITCHELL, PHILIP H. *A textbook of general physiology.* (4th ed.) New York–London: McGraw-Hill, 1949. Pp. ix + 927. (Illustrated.) $7.50.

MULDOON, HUGH C. *Organic chemistry.* (3rd ed.) Philadelphia-Toronto: Blakiston, 1948. Pp. viii + 648. (Illustrated.) $5.50.

PINCUS, GREGORY. (Ed.) *Recent progress in hormone research: the proceedings of the Laurentian Hormone Conference.* (Vol. III.) New York: Academic Press, 1948. Pp. 378. (Illustrated.) $7.80.

SCHIFF, LEONARD I. *Quantum mechanics.* New York: McGraw-Hill, 1949. Pp. xii + 404. (Illustrated.) $5.50.

SCHILLER, PAUL V. *Aufgabe der psychologie: eine geschichte ihrer probleme.* Vienna: Springer-Verlag, 1948. Pp. 233. $4.00.

SHANDS, ALFRED RIVES, JR. (in collaboration with RICHARD BEVERLY RANEY). *Handbook of orthopaedic surgery.* (3rd ed.) St. Louis, Mo.: C. V. Mosby Co., 1948. Pp. xviii + 574. (Illustrated.) $6.00.

SMITH, DAVID T., MARTIN, DONALD S., *et al. Zinsser textbook of bacteriology.* (9th ed.) New York-London: Appleton-Century-Crofts, 1948. Pp. xl + 992. (Illustrated.) $10.00.

STORER, JOHN H. *The flight of birds: analyzed through slow-motion photography.* (Bull. No. 28.) Bloomfield Hills, Mich.: Cranbrook Institute of Science, 1949. Pp. xv + 94. (Illustrated.) $2.50.

TWENEY, C. F., and HUGHES, L. E. C. *Chambers's technical dictionary.* (Rev. ed.) New York: Macmillan, 1948. Pp. viii + 976. $6.50.

VIETTE, PIERRE. *Lépidoptères homoneures.* (Faune de France, 49.) Paris: Paul Lechevalier, 1948. Pp. 8[illegible]. (Illustrated.) 550 fr.

WATSON, ROBERT I. (Ed.) *Readings in the clinical method in psychology.* New York: Harper, 1949. Pp. v + 740. $4.50.

WILSON, JOHN G. *About cosmic rays.* London: Sigma Brooks, 1948. Pp. 144. (Illustrated.) 8/6.

WOLFF, ÉTIENNE. *La science des monstres.* Paris: Librairie Gallimard, 1948. Pp. 265. (Illustrated.) 580 fr.

WORK, THOMAS S., and WORK, ELIZABETH. *The basis of chemotherapy.* New York: Interscience, 1948. Pp. xx + 435. (Illustrated.) $6.50.

———. *Ionospheric radio propagation.* (Nat. Bur. of Standards Circ. 462.) Washington, D. C.: Supt. of Documents, U. S. Govt. Printing Office, 1948. Pp. iv + 209. (Illustrated.) $1.00.

———. *The Royal Society Scientific Information Conference, June–July 1948.* London, Engl.: The Royal Society, 1948. Pp. 723. (Illustrated.) 1£ 6/.

Association Affairs

AAAS Staff Changes

Science regrets to announce the resignation on December 31 of Executive Editor Mildred Atwood Rustigan. Her capacity for hard work and her editorial and administrative ability have been of the highest value at all times during her association with the AAAS editorial staff, and really essential to the publication of *Science* since the untimely passing of the editor, Dr. Willard L. Valentine, in 1947. Miss June Armstrong, who has been associated with Mrs. Rustigan in editorial duties on *Science* and who is now serving as acting executive editor, has resigned effective February 28 to return to the Pacific Coast.

Beginning with the present issue Miss Beth Wilson becomes executive editor of *Science*. Miss Wilson has been assistant editor of *Physics Today* and had previously worked for *Fortune* and *Science Illustrated*. She is a graduate of the University of Nebraska, and a member of Phi Beta Kappa. The *Science* staff also includes Miss Dorothy Witham, Miss Jeanne Hopson, Mrs. Arlene Butterly, and Mrs. Anna H. Freedman.

Dr. F. R. Moulton retired as administrative secretary at the close of his term, January 15. His great services to American science through AAAS activities will be the subject of a later article in *Science*. As announced in the issue of November 26, 1948, Prof. Howard A. Meyerhoff is assuming the position of administrative secretary of AAAS. Until the end of the present academic year, he will also be engaged as professor of geology at Smith College.

Sincere regret is felt at the resignation on December 31, of Dr. John M. Hetzel, assistant administrative secretary, to accept an important post in government service. He will continue to serve the Association as administrative consultant. Effective February 1, 1949, the position of assistant administrative secretary will be filled by Prof. Raymond L. Taylor of Sampson College, formerly of the College of William and Mary.

Conference on U. N.

On January 14 the AAAS was officially represented by Howard A. Meyerhoff at a National Conference on the United Nations, called by the Department of State. The invitation was issued by Francis H. Russell, Director of the Office of Public Affairs, and the Executive Committee responded at its December meeting by naming as its representative the Administrative Secretary and, as an alternate, the President, E. C. Stakman. The crowded program was a successful effort to place before the 200 people in attendance the facts of diplomatic life in one vital field of U. S. international relations.

The program, which occupied a very full day, started at 9:00 A.M. with a general session of the conference, held in the State Department Auditorium. Chairman Francis H. Russell opened the conference and Acting Secretary of State Robert A. Lovett made introductory remarks. Dean Rusk, Director of the Office of United Nations Affairs, spoke on "Regional Security Arrangements Under the United Nations Charter"; Mrs. Franklin D. Roosevelt, U. S. Delegate to the General Assembly, on "Developments on Human Rights at the Paris Meeting of the General Assembly"; and Durward V. Sandifer, Deputy Director of the Office of United Nations Affairs, on "Next Steps in the United Nations Human Rights Program." At 11:30 conference members took part in round table discussions on human rights.

The luncheon meeting at the Hotel Washington was addressed by Howland W. Sargeant, Deputy Assistant Secretary of State for Public Affairs, and by John Foster Dulles, U. S. Delegate to the U. N. General Assembly, who reported on the Paris session of the General Assembly.

The mid-afternoon general session, at which Willard L. Thorp, Assistant Secretary of State for Economic Affairs, spoke on "Major Items on the Agenda of the Economic and Social Council," was followed by more round table discussions—on economic and social problems of the U. N. and regional security arrangements. The five o'clock general session was devoted to reports of the various round table discussions and the conference adjourned at 5:30 after closing remarks by the Chairman.

The conference was the first of a series of three, the purpose of which, although allegedly to provide opportunities for leading organizations concerned with international affairs "to assist in the constructive efforts of your Government toward solving the problems facing the United Nations," appears to be the frank dissemination of knowledge as to what is transpiring in the U. N. The entire meeting was refreshingly free from anything resembling propaganda. Although many of the subjects discussed lie on the periphery of science, the social and economic problems considered, in addition to being everyone's concern, have important scientific connotations. It was evidently for this reason that the 150 organizations represented at the conference included such diversified groups as the AAAS, Kiwanis International, National Association for the Advancement of Colored People, National Catholic Education Association, Railway Labor Executive Association, American Federation of Labor, Engineers Joint Council, and Church of Jesus Christ of Latter-Day Saints.

A second conference will take place in March, to consider the entire range of U. S. foreign policy; and a third, on the economic and social programs of the United Nations, is scheduled for May. The Association plans to have representation at both these meetings. (HOWARD A. MEYERHOFF, *Administrative Secretary.*)

NEWS and Notes

John S. Laughlin, who has been working on the betatron project at the University of Illinois Chicago Professional Colleges, has been appointed assistant professor of radiology and radiation physicist at the University's College of Medicine.

John H. Payne has been appointed head of the Technology Department of the Hawaiian Sugar Planters' Association Experiment Station, Honolulu.

Tracy M. Sonneborn, professor of zoology, Indiana University, will deliver the fifth Harvey Lecture of the current series at the New York Academy of Medicine on February 17. Dr. Sonneborn will speak on "Cellular Transformations."

S. Smith Stevens has been appointed director of the Harvard Psychological Laboratories, succeeding **Edwin G. Boring,** who is resigning his directorship after 25 years of service but will continue as professor of psychology.

Margery C. Carlson, assistant professor of botany at Northwestern University, is making a six-month botanical exploration of Mexico and Central America. Dr. Carlson will collect specimens of the native flora to be deposited in the Chicago Natural History Museum. The expedition is sponsored jointly by the Museum and the University.

Lawrence R. Hafstad, former executive secretary of the Joint Research and Development Board of the National Military Establishment, has been appointed director of the new Reactor Development Division of the U. S. Atomic Energy Commission. This division of the USAEC was created last August to carry out the program of designing and developing nuclear reactors for the practical application of atomic energy for power, propulsion of ships and aircraft, production of isotopes, and for research on reactors themeselves.

George W. Schaeffer, former assistant professor of chemistry at the University of Chicago, has been appointed associate professor and director of the Department of Chemistry at Saint Louis University.

David E. Lilienthal, chairman of the U. S. Atomic Energy Commission, will deliver the mid-year commencement address and receive the honorary degree of doctor of laws at Lehigh University, February 6.

J. Lanjouw, conservator of the Herbarium and Botanical Museum at the University of Utrecht, Netherlands, has been appointed professor of plant taxonomy, succeeding A. A. Pulle, retired. Dr. Lanjouw is at present in Surinam doing botanical work.

Shepard Bartnoff and **Winston H. Bostick** have been appointed instructors in physics at Tufts College.

Merritt L. Fernald, retired director of the Gray Herbarium of Harvard University, and Fisher professor emeritus of natural history, has been elected to the Royal Society of Sciences of Uppsala.

Robert R. Sears of the University of Iowa has been appointed professor of education and child psychology at Harvard University. Dr. Sears will also become director of a new laboratory of human development to promote research in the fields of motivation and learning theory.

Ford M. Milam of the University of West Virginia is now employed by the U. S. Department of Agriculture as head of the agronomy department at its experiment station in San Salvador, El Salvador, Central America.

Paul Magnus Gross, professor of chemistry at Duke University, has been elected vice president of the University in charge of the educational division. Dr. Gross is also dean of the Graduate School at Duke.

Raymond Kennedy, professor of sociology at Yale University, will leave in June to spend 15 months in Indonesia studying the influence of western civilization on native culture. The Indonesian research trip is a project of the Southeastern Asia Studies, whose headquarters in this country are at Yale. The trip will be supported by the Viking Fund, the Coolidge Fund, and the Social Science Research Council.

Grants and Awards

John Rawlings Rees, British scientist and president of the World Federation for Mental Health, has received an award of $5,000 from the International Committee for Mental Hygiene in New York, for his research into the application of psychology to international relations.

Two German scientists are to receive Nobel prizes in chemistry that Hitler had forbidden them to accept. They are Richard Kuhn of Heidelberg University, who won the prize in 1938, and A. Butenandt of Tuebingen University, who won it in 1939.

The Carl Neuberg Medal for 1948 has been awarded to F. F. Nord of the Chemistry Department of Fordham University.

Warren K. Lewis, professor emeritus of chemical engineering at the Massachusetts Institute of Technology, will be awarded the 1949 gold medal of the American Institute of Chemists at the Institute's annual meeting in Chicago in May.

Smith, Kline and French Laboratories of Philadelphia have awarded a total of 73 grants amounting to $381,761 in support of medical research during 1948. The funds provide for scholarships and fellowships, aids in preclinical research, and support of investigations in fields of clinical medicine. Twenty-seven of the grants were made to medical schools, and the balance to institutes, clinics, and individual investigators.

Mathematicians Donald C. Spencer, Stanford University, and Alfred Schaeffer, Purdue University, have been named joint recipients of the

Bocher Memorial Prize, which is awarded every five years by the American Mathematical Society. The prize is $100, and each received this amount. They were honored for their work in conformal mapping, a technical mathematical work of which one application is in computation of pressures in the flow of air over an airplane wing.

Fellowships

Duke University School of Medicine will make available on July 1 several two-year fellowships carrying stipends of $2,400 the first year and $3,000 the second year. The work will include special training, clinical and consultation practice, and teaching and research in the fields of hematology and allergy, pulmonary diseases, gastroenterology, hypertensive cardiovascular and renal diseases, metabolic diseases, cardiology, and general internal medicine and therapeutics. Applicants must have completed three years of training in internal medicine or a satisfactory equivalent. Further information may be obtained from Eugene A. Stead, Jr., Professor of Medicine, Duke University School of Medicine, Durham, North Carolina.

The Conway MacMillan Memorial Research Fellowship in Botany at the University of Minnesota is offered again to doctoral students for the year 1949–50. The award of $1,200 for the academic year is supplemented by payment of tuition fees in the Graduate School. Applications must be made by *March 1*. Address all inquiries to A. O. Dahl, Chairman of the Conway MacMillan Fellowship Committee, Department of Botany, University of Minnesota, Minneapolis 14, Minnesota.

Colleges and Universities

The Damon Runyon Laboratory of Chemical Embryology of the University of Colorado Medical Center will be housed in a new cancer research wing to be constructed at the Center through funds recently made available by the National Cancer Institute of the U. S. Public Health Service and the University of Colorado. The grant of $25,000 received last summer from the Damon Runyon Cancer Fund will be administered by representatives from the Departments of Biochemistry, Obstetrics and Gynecology, and Pediatrics. The Laboratory will be directed by Heinz Herrmann, now at Yale University and formerly at the Biological Institute of the Carlsberg Foundation, Copenhagen. He will join the staff as associate professor of pediatrics (research) on July 1, 1949.

Providence College, Providence, Rhode Island, dedicated its Albertus Magnus Science Hall on January 27–29. The new millon-dollar building will house the Departments of Biology, Chemistry and Physics.

The Building Committee of the **University of Texas Medical Branch,** Galveston, under the chairmanship of W. B. Sharp, professor of bacteriology, reports plans for new buildings at the Medical Branch to cost more than $6,000,000. These include part of a new general hospital and a private pavilion to be erected by the Sealy and Smith Foundation at an estimated cost of $3,500,000 and the Henry and Ross Zeigler Tuberculosis Hospital, to be built by funds from the Zeigler bequest.

The 2nd Symposium on Plasticity will be held at **Brown University** April 4–6, 1949, under the sponsorship of the Bureau of Ships and the Office of Naval Research, Navy Department. The principal topics will be "Structural Applications of the Theory of Plasticity" and "Dynamic Problems of Plasticity." One day will be devoted to miscellaneous contributions to theoretical or experimental phases of plasticity. Further information may be obtained from Prof. P. S. Symonds, Graduate Division of Applied Mathematics, Brown University, Providence 12, Rhode Island.

The 30-inch Jenkintown, Pennsylvania telescope, one of the 50 largest reflectors in the world, has been purchased by the **Agnes Scott College,** Decatur, Georgia.

The Fritz Engineering Laboratory of **Lehigh University** has been assigned a two-year research project aimed at checking and improving design procedures of shell roof structures of the type used in large airplane hangars and in the domes of monumental buildings. The assignment was made by the Roberts and Schaefer Engineering Company of Chicago.

The recently established Harvard Foundation for Advanced Study and Research, designed to further the interest of the Schools of Arts and Sciences, Design, Education, Engineering, and Public Administration, will provide for student housing, research, fellowships, and scholarships in the areas of graduate study encompassed by the schools. In addition to the five graduate schools, a number of non-tuition-paying University departments will participate in the Foundation. These include the Arnold Arboretum, Atkins Garden and Research Laboratory, Blue Hill Meteorological Observatory, and the following museums: Botanical, Comparative Zoology, William Hays Fogg, Germanic, Peabody, and Semitic.

Summer Programs

The Institute of Statistics of the University of North Carolina, Chapel Hill, will offer a summer session from June 9 to July 19 for research workers in other sciences who want a practical working knowledge of statistical theory, statistical consultants in various fields, those preparing to teach statistics or develop statistical theory, and students working toward a degree in applied or theoretical statistics. An announcement of the course may be obtained from the Director, Institute of Statistics, University of North Carolina, Box 168, Chapel Hill, North Carolina.

The Mount Desert Island Biological Laboratory, Salsbury Cove, Maine, will continue its tissue culture program this year June 15–September 15. Accommodations are available for about 10 investigators with research problems in the field of aseptic cultivation of tissues, organs, and embryos of plants and animals, with preference given to projects utilizing local organisms. Only applicants qualified to carry on independent research will be accepted. Applications should be sent before March 15 to Dr. Philip R. White, Institute for Cancer Research, Corinthian Avenue and Poplar Street, Philadelphia 30.

Duke University School of Medicine and Duke Hospital, Durham, North Carolina, will offer a course in medical mycology under the direction of Norman F. Conant this summer. The course will emphasize the practical aspects of the laboratory as an aid in helping establish a diagnosis of fungus infection. Classes will be held every day in the week except Sunday during the month of July. A fee of $50 will be charged for the course and a certificate will be awarded upon com-

pletion. Further information may be obtained from Dr. Norman F. Conant, Duke University School of Medicine.

Industrial Laboratories

The problems of research and engineering involved in improving the chemical processes of plutonium production have been assigned to the **E. I. duPont de Nemours and Company** by the U. S. Atomic Energy Commission. The survey will include study of means to increase the amount of plutonium produced from a given quantity of uranium and ways to simplify the handling of the wastes of the production process.

Production of water-white single crystals of pure calcium tungstate in research quantities has been announced by the **Linde Air Products Company,** Unit of Union Carbide and Carbon Corporation. Two of their major uses, as indicated by the Company, are in scintillation counters in the detection and measurement of radioactivity, and as screens in X-ray fluoroscopy.

The Multi-Tron Laboratory of Chicago has been established to conduct research and development in the fields of electronics, radiation, optics, and nuclear physics, with special emphasis on high and low voltage electronic tubes.

Westinghouse Electric Corporation has named William E. Shoupp and Robert A. Bowman to direct the research and engineering respectively of its new Atomic Power Division. Dr. Shoupp is the former manager of electronics and nuclear physics research at the Westinghouse Research Laboratories in Pittsburgh, and Dr. Bowman the former manager of condenser engineering at the Company's Steam Division in South Philadelphia. The Division's activities will include construction and testing of an atomic power plant for the propulsion of naval vessels.

John W. Coltman has been appointed manager of the electronics and nuclear physics department of the Westinghouse Research Laboratories. Dr. Coltman, former head of the X-ray section, succeeds **William E. Shoupp,** who was recently named director of research for the Westinghouse atomic power division.

Meetings and Elections

The Seventh Pacific Science Congress will be held in Auckland and Christchurch, New Zealand during the month of February. It is expected that 30 countries interested in Pacific problems will be represented at the Congress, which plans for meetings covering geology, geophysics, meteorology, oceanography and marine biology, zoology, botany, soil resources, forestry, agriculture, anthropology, public health, nutrition, and the social sciences. Seventy-one American scientists are planning to participate in the program, some of whom will stop over in American Samoa to consult with those engaged in scientific research there.

The Ohio Alpha Chapter of Alpha Epsilon Delta, national premedical society, will be host for a state-wide convention of premedical students, advisors, and faculty members of all the liberal arts colleges in the state at the Ohio State University, Columbus, on February 19.

The annual **Louisiana State University Symposium on Modern Methods of Analytical Chemistry** will be held March 2–5 in Baton Rouge. A formal program of lectures and round table discussions has been planned. Hotel reservations should be made as soon as possible by writing: Dr. Philip W. West, Coates Chemical Laboratory, Louisiana State University, Baton Rouge 3, Louisiana.

The Optical Society of America will hold its winter meeting in New York City March 10–12. Headquarters will be the Hotel Statler (formerly Hotel Pennsylvania). The meeting will be open to non-members of the Society.

The American Chemical Society will hold its 115th national meeting in San Francisco March 28–April 1. Air pollution, the cause and treatment of high blood pressure, and chemical aspects of heredity and mutations are among the subjects to be discussed.

The 2nd National Symposium on Recent Advances in Antibiotics Research, sponsored by the Antibiotics Study Section of the National Institutes of Health to stimulate research in this field, will be held in Washington, D. C., on April 11–12. All interested persons may not only attend the meetings but also participate in the proceedings by presenting reports of current investigations in the field. Only papers concerned with original and unpublished observations can be considered, however. It is hoped that all accepted papers can be published as a single monograph or as a supplement by one of the scientific journals. All abstracts of papers (in triplicate) should be sent to Dr. Leonard Kard, Executive Secretary, Antibiotics Study Section, Division of Research Grants and Fellowships, National Institutes of Health, Bethesda, Maryland, before March 10.

The Mathematical Association of America elected the following officers at its annual meeting in December: president, R. E. Langer, University of Wisconsin; second vice president, M. H. McCoy, Smith College; members of the board of governors: C. B. Allendoerfer, Haverford College and R. J. Walker, Cornell University. Continuing in office from last year are Saunders MacLane, University of Chicago, first vice president, and H. M. Gehman, University of Buffalo, secretary-treasurer. Dates were set for 1949 meetings: June 20–21, a joint meeting with the American Society for Engineering Education at Rensselaer Polytechnic Institute, Troy, New York; August 29–30, the 31st summer meeting, at the University of Colorado, Boulder, Colorado; December 30, the 33rd annual meeting, in New York City.

The Pacific Chemical Exposition is scheduled for November 1–5 at the San Francisco Civic Auditorium. James O. Clayton, research associate of the California Research Corporation has been appointed chairman.

At the 18th annual meeting of the **Western Society of Naturalists,** held at Occidental College, Los Angeles, December 28–30, 1948, officers were elected as follows: President, Richard M. Eakin, Department of Zoology, University of California, Berkeley; vice-president, Lyman Benson, Departm

of Botany, Pomona College; secretary-treasurer, William M. Hiesey, Division of Plant Biology, Carnegie Institution of Washington, Stanford; members at large on the executive committee, Margaret H. Storey, Natural History Museum, Stanford University, and F. M. Scott, Department of Botany, University of California, Los Angeles.

The American Microscopical Society, at its recent annual meeting held in Washington, D. C., elected the following officers for 1949: Clarence E. Taft, president; Irene McCulloch, first vice president; David C. Chandler, second vice president; Frank E. Eggleton, secretary-editor; Alden B. Dawson, elective member of the executive committee.

The Hawaii Psychological Association, recently formed by a group of fellows and associates of the American Psychological Association in Hawaii, elected the following officers for 1949: president, Theodore W. Forbes; president-elect, Colin J. Herrick; secretary-treasurer, Helen E. Peixotto; representative to the APA, W. Edgar Vinacke; and representative at large to the executive council, Mildred C. Mendenhall.

The American Academy of Dental Medicine will hold its annual meeting June 4–5 at the Statler Hotel in New York City. One feature of this year's program will be a symposium and round table discussion on psychosomatics. Further information can be obtained from Dr. William M. Greenhut, National Secretary, 124 East 84th Street, New York City 28.

Deaths

Gertrud Oppenheimer, 55, German chemist who had been at the California Institute of Technology since 1942, died August 27, 1948, in an automobile accident.

Ryozo Kanehira, Japanese forester and botanist, died in Tokyo on November 27. From 1942–1945, Dr. Kanehira served as director of the library and herbarium at Butienzorg, Java, and was instrumental in making living conditions for the interned scientists more satisfactory there. Later, he became technical consultant in forestry to the Natural Resources Section, G.H.Q., Tokyo.

Adolph R. Ringoen, 62, a member of the Department of Zoology of the University of Minnesota for the past 36 years, died January 13 in Minneapolis.

James F. McKernon, 83, professor of otology, who was president of the New York Post-Graduate Medical School and Hospital for 14 of his 26 years' service there, died January 23 at his New York City home.

Tenney L. Davis, 59, professor emeritus of organic chemistry at M. I. T. and former secretary of the American Academy of Arts and Sciences, died January 25 in Norwell, Massachusetts. Upon retiring from the M. I. T. staff in 1942, Dr. Davis became director of scientific research for the National Fireworks Company of Hanover, Massachusetts.

Lithium deuteride and lithium aluminum deuteride are now being synthesized by Metal Hydrides, Inc. and can be purchased from this source at cost by research organizations having need for the material. Information regarding price and availability may be secured from Metal Hydrides, Inc., 12–24 Congress Street, Beverly, Massachusetts. Blanks (AEC Form 100) for obtaining the necessary approval from the AEC will be sent on request by the Company or the Isotopes Division, USAEC, P. O. Box E, Oak Ridge Operations, Oak Ridge, Tennessee.

A new lightweight film-cassette changer for taking stereoscopic views of the human chest has been developed for military field use by the Engineering Development Division of the Army-Navy Medical Procurement Office at its Fort Totten, New York laboratories. The new apparatus weighs only 75 pounds, as compared with currently available models ranging from 370–700 pounds, and has a volume of only 4.6 cubic feet. Lightweight construction has been attained by the elimination of heavy counterweights and by the use of lighter metals, principally aluminum.

Veterinarians are needed by the Bureau of Animal Industry of the U. S. Department of Agriculture for work in such fields as Federal meat inspection and research, in the control of animal diseases. Graduates of recognized veterinary colleges who are interested may obtain further details by writing to the Bureau of Animal Industry, Agricultural Research Administration, U. S. Department of Agriculture, Washington 25, D. C.

A previously uncharted natural arch of white sandstone in southern Utah has been named Grosvenor Arch in honor of Gilbert Grosvenor, president of the National Geographic Society, by Jack Breed, Boston naturalist who discovered it during his Escalante Expedition from Bryce Canyon last summer. The arch thrusts eastward from a massive ridge and towers 152 feet above the valley floor. The underside of the main arch is 139 feet high, but the opening is worn only part of the way down, being 40 feet wide and 73 feet high. A second opening, 6 feet high and 4 feet wide, is close to the top and creates a double arch effect.

The Florida Academy of Science has completed the first 10 volumes of its *Quarterly Journal*. The Academy has attempted to include in the publication as little on its own business and as much original research material as possible. Papers are accepted entirely on merit.

Southwest Research Institute, the Institute of Inventive Research, and the **Foundation of Applied Research** have announced the following new appointments to their technical staffs: to SWRI, Charles E. Balleisen, Duffer B. Crawford, Dean Hawley, Maurice Holland, Leopoldo H. Mayoral, Gilbert D. McCann, Apolonio L. Morales, Ray Neumann, Norman C. Penfold, Kenneth Shaftan, Erwin R. Strong, Jr., and Judson S. Swearingen; to IIR, Ion Edeleanu; and to FAR, Wayne A. Kalenich, Travis S. Richardson, and Raymond Umbaugh.

The Philadelphia Section of the American Chemical Society will sponsor two special noncredit courses on sulfur chemistry and on process control, each of which will be offered on ten successive Monday evenings, beginning February 21. The Section

has also arranged a series of lectures on the administration of industrial research, which will be presented on Tuesday evenings. The classes will be open to both members and non-members of the Society and will be located in the Philadelphia College of Pharmacy and Science, 43rd and Kingsessing Avenue, Philadelphia. Further information may be obtained from Dr. J. F. Gall, Whitemarsh Research Laboratories, Pennsylvania Salt Manufacturing Company, Wyndmoor, Pennsylvania.

Fossil remains of fish and plants of the Upper Triassic period (175,000,000 years ago) are being excavated near Haymarket, Virginia by David H. Dunkle, Smithsonian Institution paleontologist. The fish, which presumably lived in a fresh-water lake, were ancient forms of bony fishes whose extant descendants are the gar pike and the bow fin, or fresh-water dogfish. The ancient forms were hitherto poorly known in this region, although they are similar to those commonly found in rocks of comparable age in Massachusetts, Connecticut, and New Jersey.

Applications are being reviewed for the newly created position of Director of Research and Development at the Engineers Research and Development Laboratories, Corps of Engineers, U. S. Army, Fort Belvoir, Virginia. It is open to individuals with at least fifteen years' experience, exclusive of graduate work, ten of which should have been in research or as a research or development engineer. Five of the fifteen years' experience should have been as the chief of a branch or department of a research and development organization. The salary is $12,500 per year. Applications may be made either in person or by letter to the Commanding Officer at the Laboratories.

Scientific writers and medical statisticians are needed at the Communicable Disease Center of the Public Health Service in Atlanta, Georgia. It it highly desirable that applicants for both types of position have experience in the biological sciences. The positions are under federal civil service and salaries range from $4,479.60 to $10,305.00 per year (most of the jobs available are at the lower rate of pay). Further information may be obtained from S. R. Gervin, personnel officer at the Center.

The Public Health Research Institute of the City of New York has completed preliminary work toward setting up a laboratory for determining the Rh factor in human blood. Another laboratory recently developed performs virus diagnosis for physicians free of charge. Both laboratories are operated by the Bureau of Laboratories of the Department of Health.

Reserve commissions in the U. S. Army ranging from second lieutenant to a full colonel are available to qualified mathematicians and statisticians. Applicants must be citizens of the United States and between the ages of 21 and 55 inclusive. Full details of the commissioning program are provided in Department of the Army Circular No. 210, which may be obtained, together with application forms, from local Reserve Unit Headquarters or from Organized Reserve Unit Instructors, or by writing to Army Headquarters at New York, Baltimore, Atlanta, Chicago, Houston, or San Francisco.

The first license to manufacture oil from coal in the Union of South Africa was granted to the Anglo Transvaal Consolidated Investment Company. A designed capacity of 76,000,000 gallons of liquid fuel and oil a year is provided for and the coal will come from the deposits situated in the Vredefort district of the Orange Free State.

The Forest Service of the U. S. Department of Agriculture is studying means for avalanche control. Continuous skiing in some areas has been observed to keep the snow well enough packed so that it is not likely to slide. Recent experiments at Alta, Utah, showed that it is also possible to avert a slide by setting off explosives in danger spots when the area is clear of visitors.

Make Plans for—

American Mathematical Society, February 26, meetings in New York City and Chicago.

American Institute of Chemical Engineers, regional meeting, March 6–9, Los Angeles, California.

Institute of Radio Engineers, convention, March 7–10, Hotel Commodore and Grand Central Palace, New York City.

American Physical Society, Division of Solid State Physics, annual meeting, March 10–12, Hollenden Hotel, Cleveland, Ohio.

Optical Society of America, winter meeting, March 10–12, New York City.

Recently Received—

German gas turbine developments during the period 1939–1945. British Intelligence Objectives Sub-Committee Overall Report No. 12. British Information Services, 30 Rockefeller Plaza, New York 20, N. Y. $3.5

Fundamental education. (Bulletin 1948 No. 13, Office of Education, Washington 25, D. C.: Supt. of Documents, U. S. Government Printing Office, 1948. $.10.

Bulletin of the American Physical Society, programme of the 1948 annual meeting at Columbia University, January 26–29, 1949. Lancaster, Pennsylvania: Prince and Lemon Streets. $1.00.

The memorial review. Published by the Women's Society of Memorial Hospital Center for Cancer and Allied Diseases, 444 East 68th Street, New York 21, N. Y.

Report of the Chief of the Bureau of Entomology and Plant Quarantine, 1948. Publication of the Agricultural Research Administration, U. S. Department of Agriculture. Washington 25, D. C.: Supt. of Documents, U. S. Government Printing Office, 1949. $.15.

Further new Cambrian Bellerophontid Gastropods by J. Brooks Knight. (Publ. 3951.) Washington, D. C. Smithsonian Institution, 1948.